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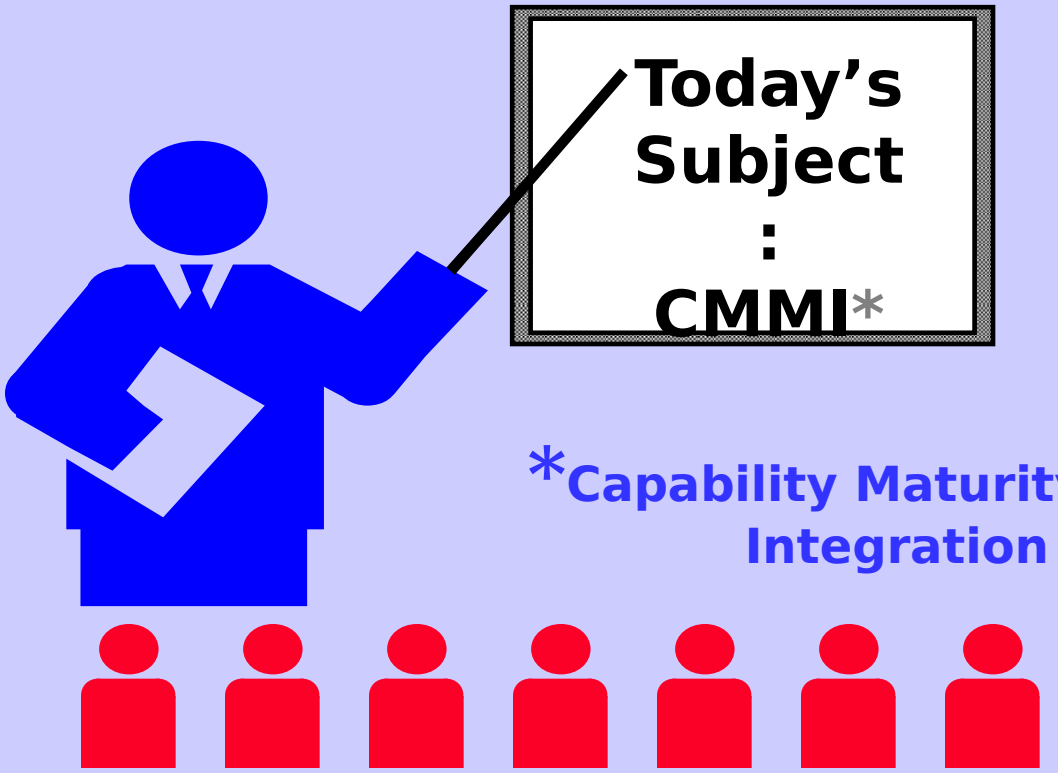
Systems/Software Process Improvement Working Group (SPIWG)



CMMI®

*Capability Maturity Model Integration

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SPIWG Charter

- To exchange information on ways to improve SSC-SD products and services

- To provide a forum for Center personnel to discuss experiences in producing quality systems/technical services

- To highlight, demonstrate, and discuss important advances in systems engineering technology

- To gain from the knowledge and insight of guest speakers

We Invite Your Suggestions on Future SPIWG Topics!

Your SPIWG POC is SEPO, Code 20203, email: sepo@spawar.navy.mil

SPIWG Host: SSC San Diego Systems Engineering Process Office

- Established by SSC San Diego to improve product quality and life cycle costs of development products/technical services
- Provides training (Project Mgmt Core Course, Introduction to Best Practices, etc.) to enhance the Center's competencies in systems engineering and project management
- Maintains a website (http://sepo.spawar.navy.mil) that serves as a repository for standard organizational policies, guidelines, and practices for effective systems engineering and project management
- Facilitated efforts leading to SSC San Diego meeting LEVEL THREE maturity criteria as described in the Software Engineering Institute's Capability Maturity Model for software
- Implementing Project Management Policy, Project Management Guide and Systems Engineering

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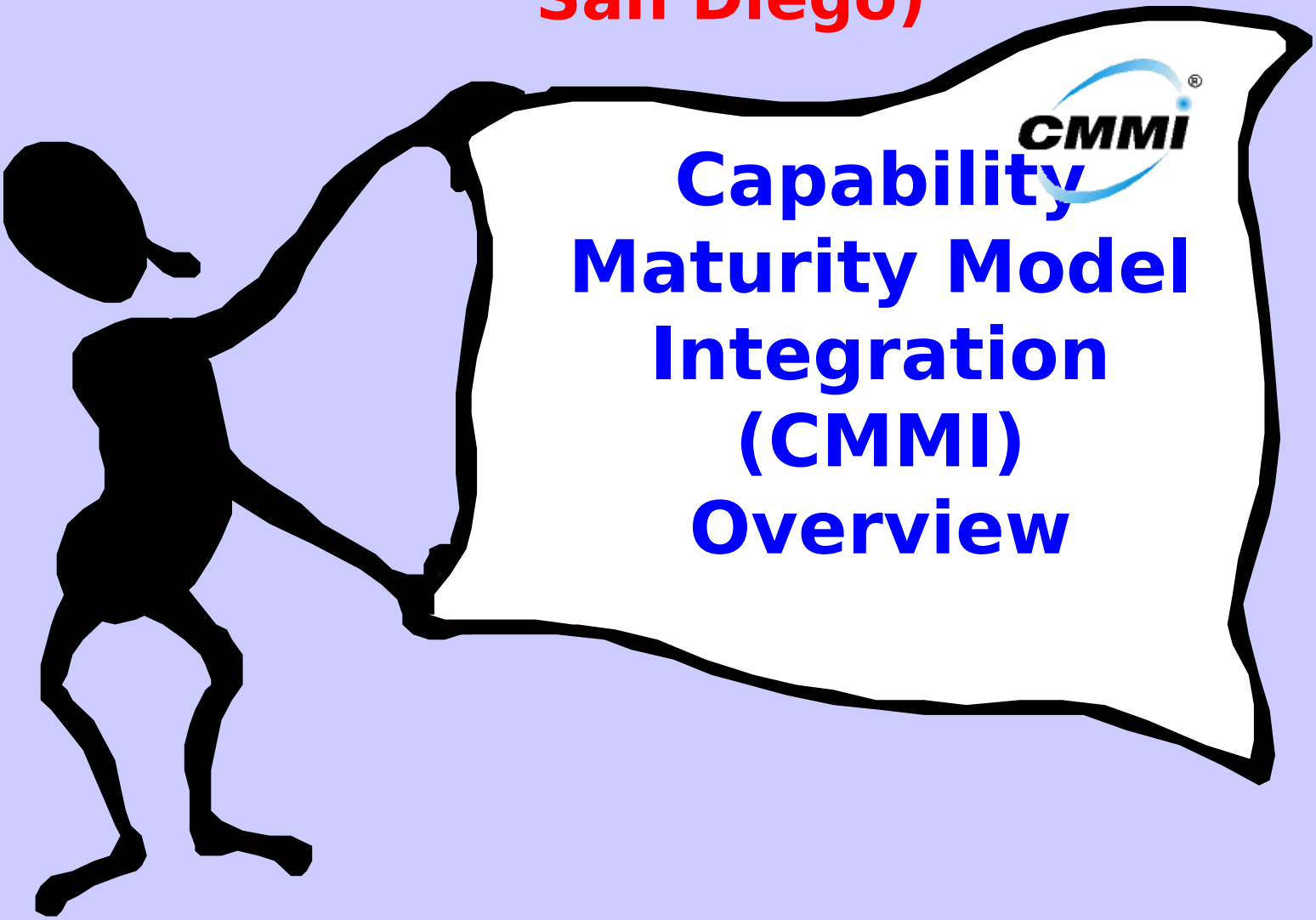
Space and Naval Warfare Systems Center San Diego (SSC San Diego)



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CMMI Elevator Speech

- CMMI is for projects or organizations that:
  - Need to manage the acquisition, development, and maintenance of products or services
  - Are concerned about cost and schedule overruns or unhappy users / stakeholders
  - Are concerned about costs of quality and rework
  - Are seeking a competitive advantage
- It is a process improvement method that provides a set of best practices to address productivity, performance, costs, and stakeholder satisfaction. Unlike:
  - The SW-CMM or SE-CMM, CMMI focuses on the total system problem
  - Single-discipline models that can result in confusion and higher costs, CMMI facilitates enterprise-wide process improvement
  - Asynchronous initiatives that result in bolt-ons that last only as long as the squeaking:
    - CMMI provides a consistent, enduring framework that can accommodate new initiatives
    - CMMI integrates well with current best practices, process improvement, or quality management strategies (Lean Six Sigma, PMBOK, SW-CMM, etc.)

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Purpose of this Overview

- This briefing provides an initial point for “contact and awareness” of the CMMI, the elements of this model (the Process Areas - PA) with high-level descriptions of each PA, and reference materials
- This briefing will NOT discuss in-depth implementation of the CMMI PAs – this activity is the responsibility of the Department SPI agents who, working with SEPO and your designated project SPI lead, would undertake the tailoring of SSC San Diego organization standard processes to comply with CMMI
- Agenda of today’s presentation
  - Module 1 addresses the basic project management processes
  - (10 minute break)
  - Module 2 addresses the higher-level maturity processes
  - (10 minute break)
  - Module 3 addresses current SSC SD direction regarding CMMI, provides a plan of action for implementing CMMI, and focuses on questions you may have about CMMI

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Do Projects Deliver Quality Products on Time and within Budget?

- Nearly 1/3 of information technology (computer and software) projects were cancelled before completion
- Average overrun of project budgets was 189%
- The average schedule overrun for projects that were in difficulty was 222%
- On average, the delivered product contained only 61% of the originally-specified features.
- Only 16% (1 of 6) software projects were completed on time, on budget

"Charting the Seas of Technology: The CHAOS Study" The Standish Group, January 1995
Report of the Defense Science Board Task Force on Defense Software, November 2000

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Why do Projects Fail?

- Failure to manage risks
- Poor or mismanaged requirements
- Misunderstood user needs
- Poor, undefined, or unproved processes
- Lack of consideration for the entire product / service lifecycle
- Lack of planning for transition to deployment
- Inadequate management of the procurement process

These problems are Managerial – not Technical !

Adapted from Software Engineering Institute, 1998

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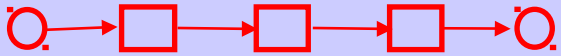
Attributes of Successful Projects

- Effective project planning
- Effective project cost estimating
- Effective project measurements
- Effective project milestone tracking
- Effective project quality control
- Effective risk management
- Effective project change management
- Effective processes
- Effective communications
- Capable project managers
- Capable technical personnel
- Significant use of specialists
- Substantial volumes of reusable material

Adapted from Patterns of Software System Failure and Success, Capers Jones

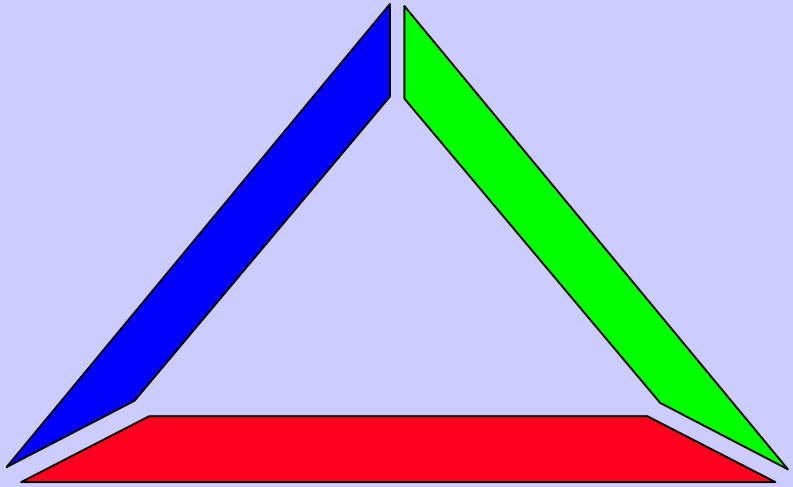
The Three Elements of Project Success

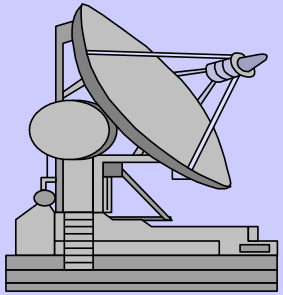


Process: a defined method involving steps or operations

People:

Skills, Training, Management





Technology:

Application domains, tools, languages, information, environments

Improved Process + Competent Workforce + Appropriate Technology

=

Reduced Risk, Higher Productivity, and Better Quality

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Capability Maturity Models - Overview

- A representation of the engineering and management “world”
- Focuses on elements of essential practices and processes from various bodies of knowledge
- Describes common sense, efficient, proven ways of doing business (which you should already be doing) - not a radical new approach
- Presents a minimum set of recommended practices and leverage points that have been shown to enhance organizational maturity and project capability
  - It defines the expectation (the “what”)
  - Without overly constraining the implementation (the “how”)
- Example implementations of CMMs:
  - People CMM: develop, motivate and retain project talent
  - Software CMM: enhance a software focused development and maintenance capability
  - CMMI: focuses on systems and software engineering process development

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What is this CMMI?

- **What it is:** A process improvement model that provides a set of industry-recognized practices to address productivity, performance, costs and stakeholder satisfaction in the systems engineering and software development process.
  - Helps your organization examine the effectiveness of your processes
  - Establishes priorities for improvement
  - Helps you implement these improvements

- **How it is different:** The CMMI provides an integrated, consistent, enduring framework for enterprise-wide process improvement and can accommodate new initiatives as future needs are identified. Unlike single-discipline or stove-pipe models that can result in confusion and higher costs when implemented together.
- **Who it is for:** Those providing systems and software engineering products and services to organizations who transform customer needs expectations, and constraints into products, and supporting these products throughout their life. **If you manufacture, code, analyze, maintain or document a product, you need this!**

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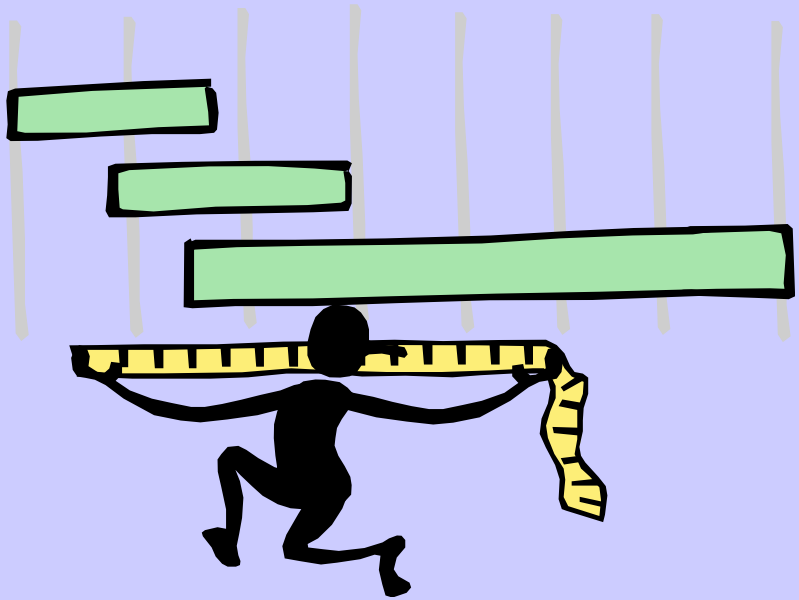
What is this CMMI?

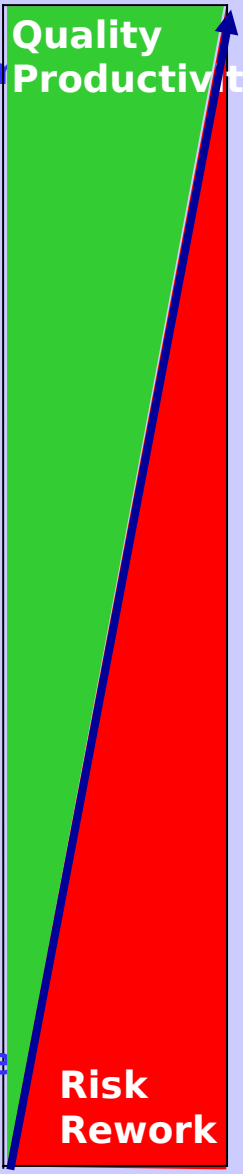
CMMI®

- **CMMI PROVIDES A YARD STICK TO MEASURE THE ACCOMPLISHMENT OF BEST PRACTICES.**



CMMI SE/SW/IPPD/SS Staged Representation

Level	Focus	Process Areas
5 Optimizing	*Continuous Process Improvement*	Organizational Innovation and Deployment Causal Analysis and Resolution
4 Quantitatively Managed	*Quantitative Management*	Organizational Process Performance Quantitative Project Management
3 Defined	*Process Standardization*	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Mgmt (with IPPD extras) Risk Management Decision Analysis and Resolution Integrated Teaming (IPPD only) Org. Environment for Integration (IPPD only) Integrated Supplier Management (SS only)
2 Managed	*Basic Project Management*	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Initial		



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Level 1: the “Initial” Level
Success depends on heroes

Good performance is possible – but…

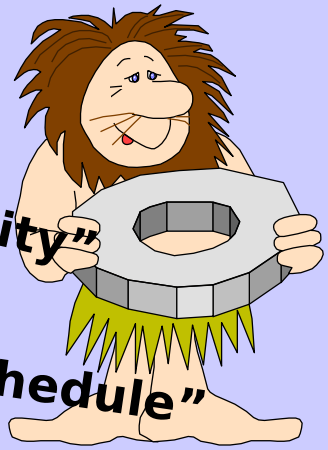
- **Requirements often misunderstood, uncontrolled**
- **Schedules and budgets frequently missed**
- **Progress not measured**
- **Product content not tracked or controlled**
- **Engineering activities nonstandard, inconsistent**
- **Teams not coordinated, not trained**
- **Defects proliferate**

“Just send in the Tiger Team”

“Schedules run everything”

“Processes limit my creativity”

“Processes don’t help my delivery schedule”



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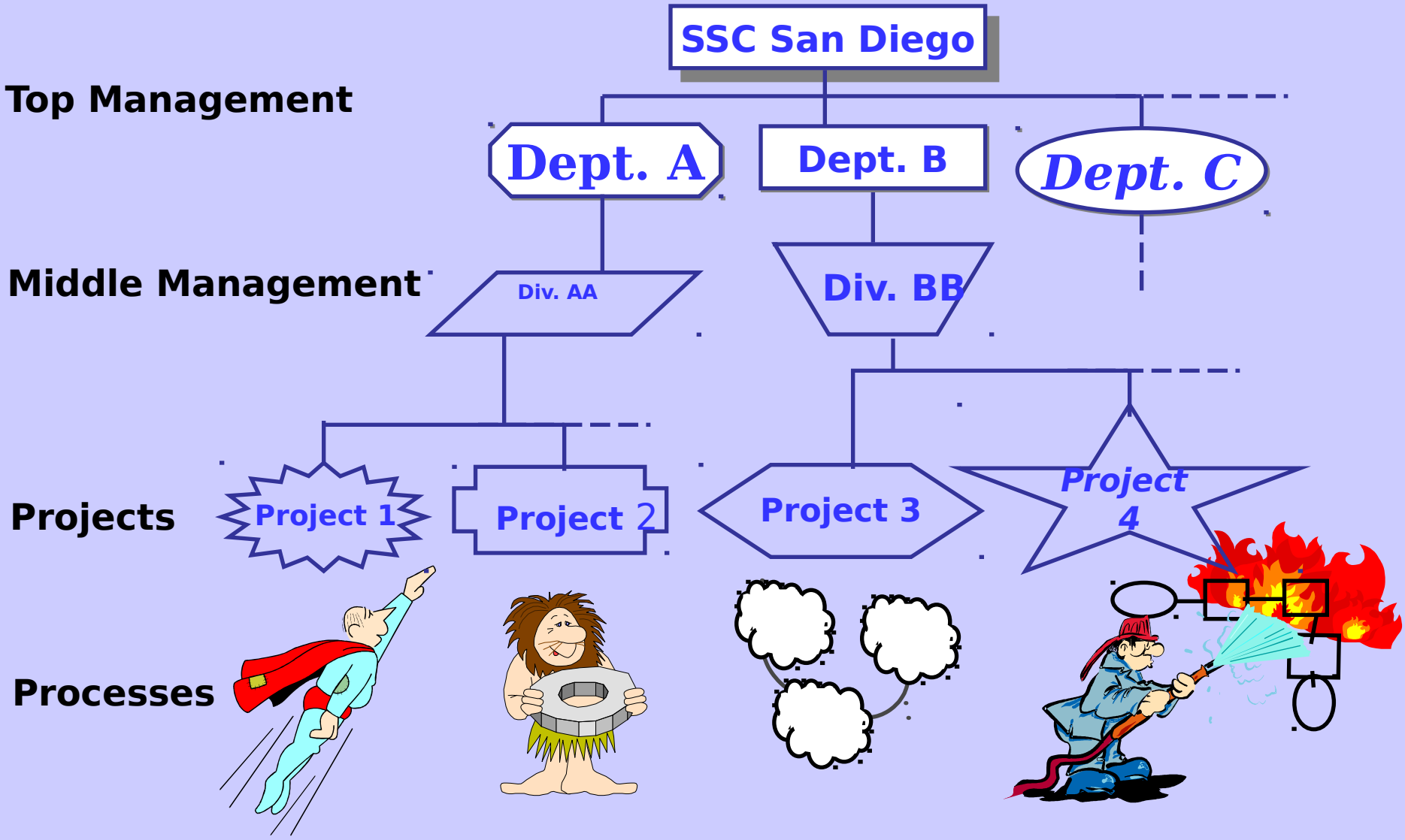
Where We've Been

Few processes in place



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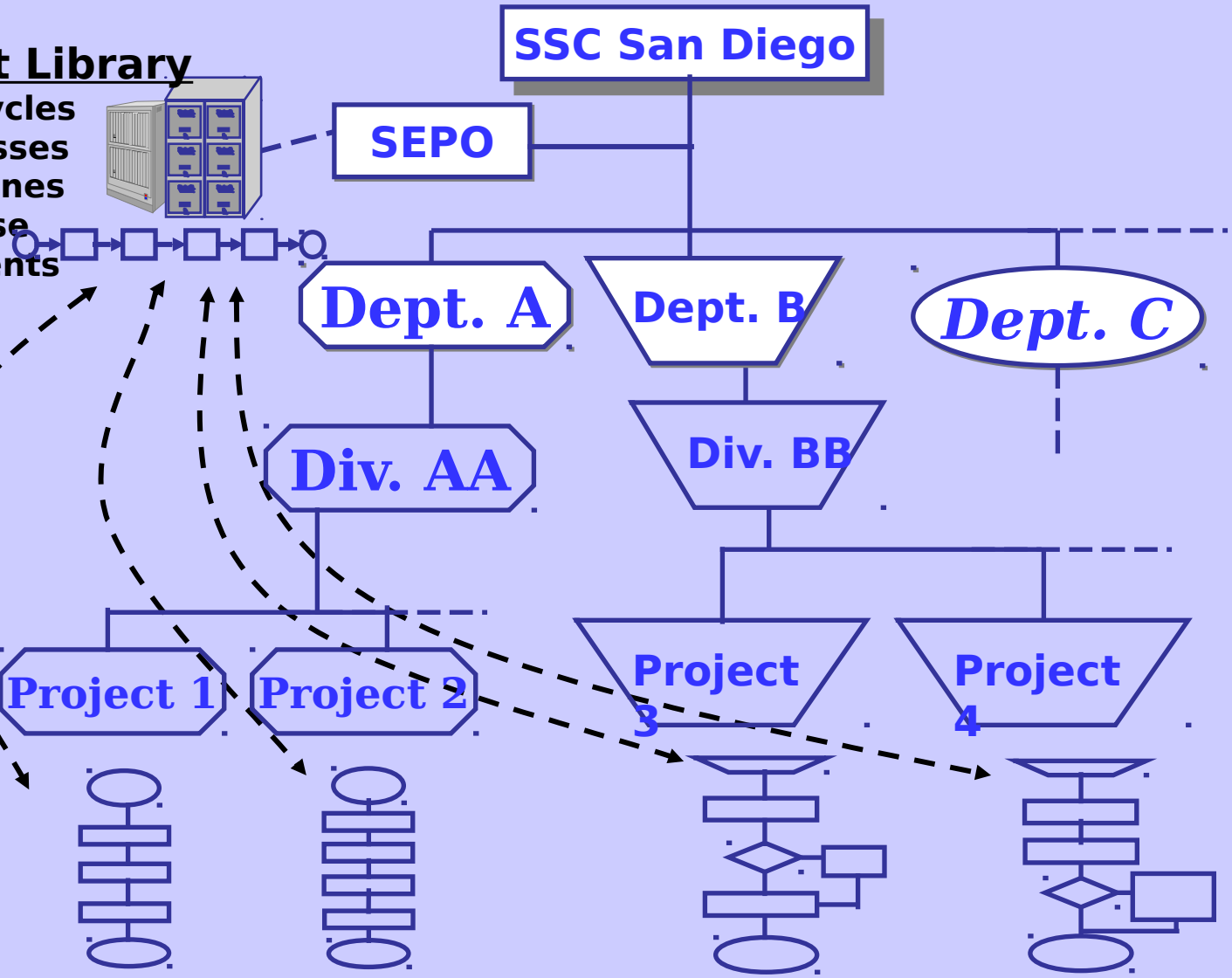
Where We're Heading

Processes based on organization's Process Asset Library (PAL)

Process Asset Library

- Approved life cycles
- Standard processes
- Tailoring guidelines
- Process database
- Related documents



MODULE 1
Implementing Managed Processes The Foundation (CMMI Maturity Level 2)

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CMMI Level 2: the "Managed" Level - Establishing basic project controls

CMMI®

CLARIFY REQUIREMENTS
- Baseline the product requirements

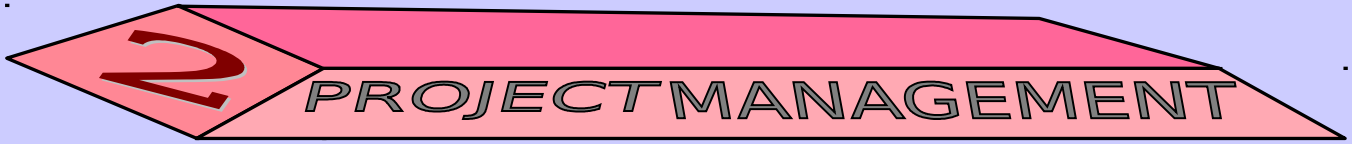
DOCUMENT PLANS
- Estimate project parameters,
- Develop plans and processes

TRACK PROGRESS
- Measure actual progress to enable timely corrective action
- Measure for mgmt. info needs
- Verify adherence of processes and products to requirements

CONTROL PRODUCTS
- Identify and control products, changes, problem reports
- Select qualified suppliers / vendors; manage their activities

7 Process Areas

- ***Requirements Management (REQM)***
- ***Project Planning (PP)***
- ***Project Monitoring and Control (PMC)***
- ***Measurement & Analysis (M&A)***
- ***Process & Product Quality Assurance (PPQA)***
- ***Configuration Management (CM)***
- ***Supplier Agreement Management (SAM)***



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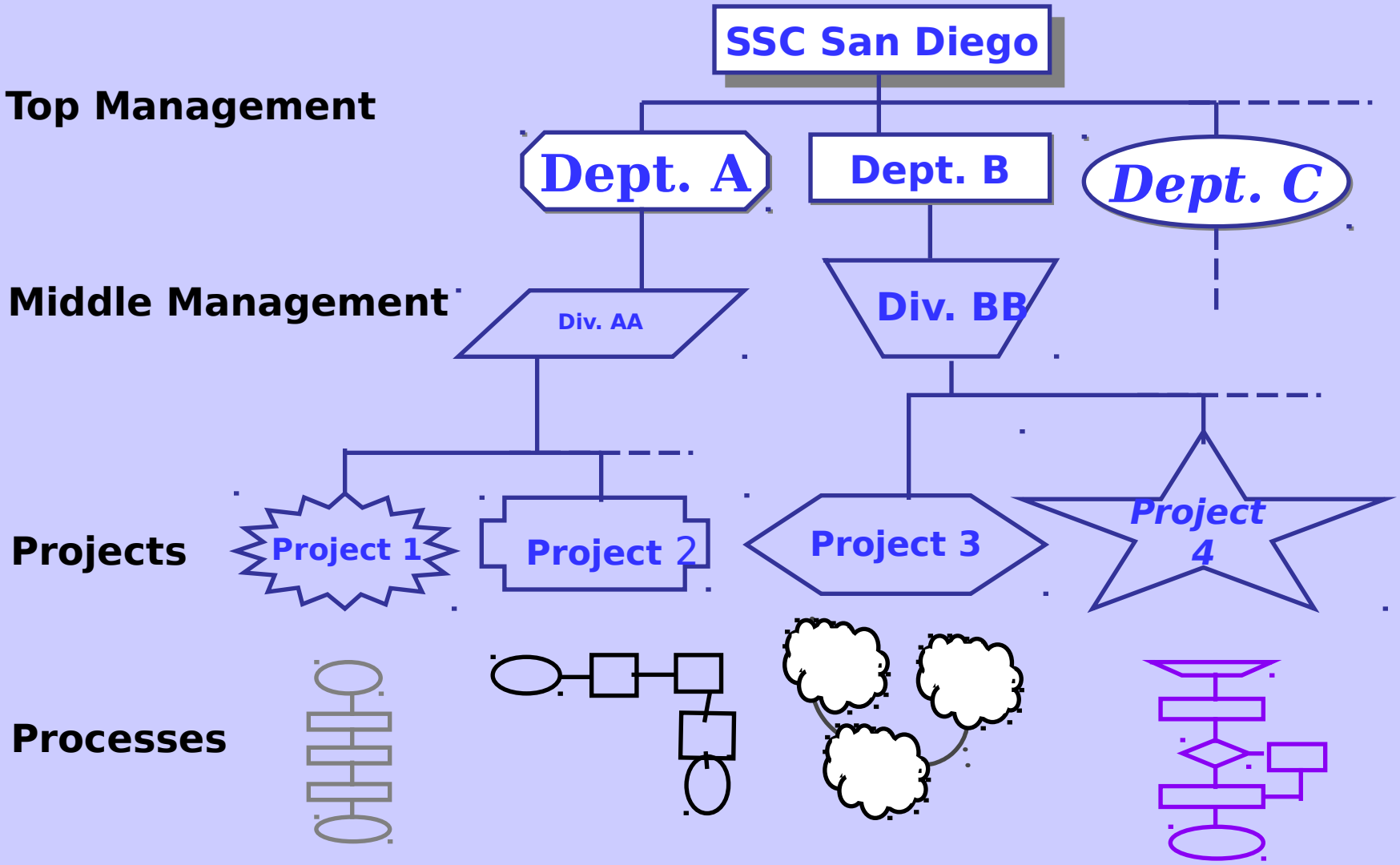
Sample Level 2 Organization

Many processes in place; and are project-specific



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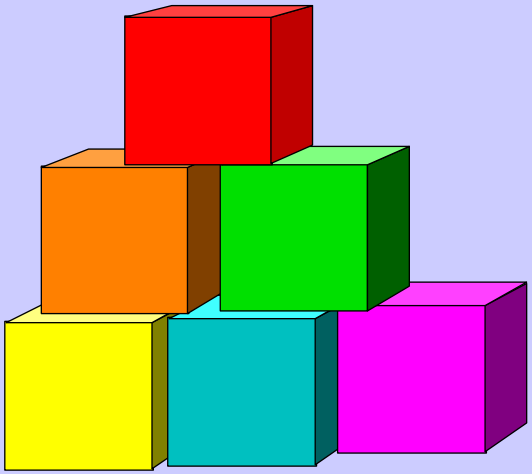
CMMI Process Area (PA) Structure

Each of the CMMI Process Areas (PAs) has:

- Purpose Description
- Specific Goals (SG)
- Specific Practices (SP) for each goal
- Generic Goal (GG): Institutionalize a Managed Pro
- Generic Practices (GP)
    1. Establish an Organizational Policy
    2. Plan the Process
    3. Provide Resources
    4. Assign Responsibility
    5. Train People
    6. Manage Configurations
    7. Identify and Involve Relevant Stakeholders
    8. Monitor and Control the Process
    9. Objectively Evaluate Adherence
    10. Review Status with Higher-Level Manageme



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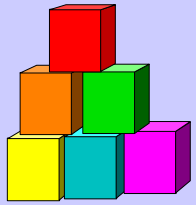
Sample: Structure of the CMMI Project Planning PA



Purpose: Establish and maintain plans that define project activities

Goals	Practices
SG1 Estimates of project planning parameters are established and maintained	1.1 Estimate the scope of the project 1.2 Establish estimates of work product and task attributes 1.3 Define project life cycle 1.4 Determine estimates of effort and cost
SG2 A project plan is established and maintained	2.1 Establish the budget and schedule 2.2 Identify project risks 2.3 Plan for data management 2.4 Plan for project resources 2.5 Plan for needed knowledge and skills 2.6 Plan stakeholder involvement 2.7 Establish the Project Plan
SG3 Commitments to the plan are established	3.1 Review plans that affect the project 3.2 Reconcile work and resource levels 3.3 Obtain plan commitment
GG2 The process is institutionalized as a managed process	(see 10 generic practices)

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Requirements Management (RM)

- To "manage requirements" means to:
  - Document current requirements
    - Received or generated by the project and / or the organization
    - Including both technical and non-technical requirements (e.g.,processes, standards, etc)
  - Have a RM plan
  - Have a list of "approved requirements providers"
  - Ensure project team commits to the requirements
  - Ensure that the "approved requirements" are the basis of project plans / activities
  - Document requirements changes and rationale
  - Maintain bi-directional traceability between source requirements and all product and product-component requirements

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Project Monitoring and Control (PMC)

- **Its purpose is to provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance departs significantly from the plan**
  - **Actual performance and progress of the project are monitored against the project plan**
    - Actuals against estimates (cost, effort, schedule, estimates of work product size, etc.)
    - Commitments & risks
    - Stakeholder involvement & progress reviews
  - **Corrective actions are managed to closure when performance / results depart significantly from plan**
    - Analyze issues
    - Plan and manage plan for their correction

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Supplier Agreement Management (SAM)

- Its purpose is to manage the acquisition of products from suppliers for which there exists a formal agreement
  - Agreements with the suppliers are established and maintained
    - Identify vendor/supplier needs and determine how to fulfill them
    - Select vendors/suppliers based on proposal responses, requirements, established criteria and risks
    - Establish and maintain formal agreement (i.e., contract or SOW)
  - Agreements with the suppliers are satisfied by both the project and the supplier
    - Acquire (receive, select, etc.,) products to satisfy needs
    - Execute agreements and monitor performance
    - Ensure agreement is satisfied prior to accepting product (e.g. testing, peer reviews, audits, etc.,)
    - Have a plan to transition products to project

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Measurement & Analysis (M&A)

- Its purpose is to develop and sustain a measurement capability that is used to support management information needs
- Measurement objectives and activities are aligned with identified information needs and objectives
  - Think ahead about necessary criteria for specifying measures and analysis procedures, and concurrently consider the constraints imposed by data collection and storage
  - Specify the essential analyses that will be conducted before attending to details of measurement specification, data collection, or storage
- Measurement results that address identified information needs and objectives are provided
  - Results based on objective evidence can help to monitor performance, fulfill contractual obligations, make informed management and technical decision, and enable corrective actions to be taken.

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Process and Product Quality Assurance (PPQA)

- **Its purpose is to provide staff and management with objective insight into processes and associated work products**
- **Objective evaluation → verifying activities and products by means other than those used to produce them**
  - **Achieved by both independence and the use of criteria**
- **Adherence of the performed process and associated work products and services to applicable process descriptions, standards, and procedures is objectively evaluated**
  - Evaluate processes, work products and services against requirements (descriptions, standards, procedures, plans, etc.,) and report results
- **Noncompliance issues are objectively tracked and communicated, and resolution is ensured**
  - Communicate, resolve to closure, or escalate non-compliance
  - Maintain quality records, logs, reports and trends

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Configuration Management (CM)

- Its purpose is to establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.
  - Baselines of identified work products are established
    - Identify Configuration Items
    - Establish a Configuration Management System
    - Create or Release Baselines
  - Changes to the work products under configuration management are tracked and controlled
    - Track Change Requests
    - Control Configuration Items
  - Integrity of baselines is established and maintained
    - Establish Configuration Management Records
    - Perform Configuration Audits

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Module One Backup Materials

- **CMMI Level 2 Process Area Flow Diagrams**

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Project Planning - SGs

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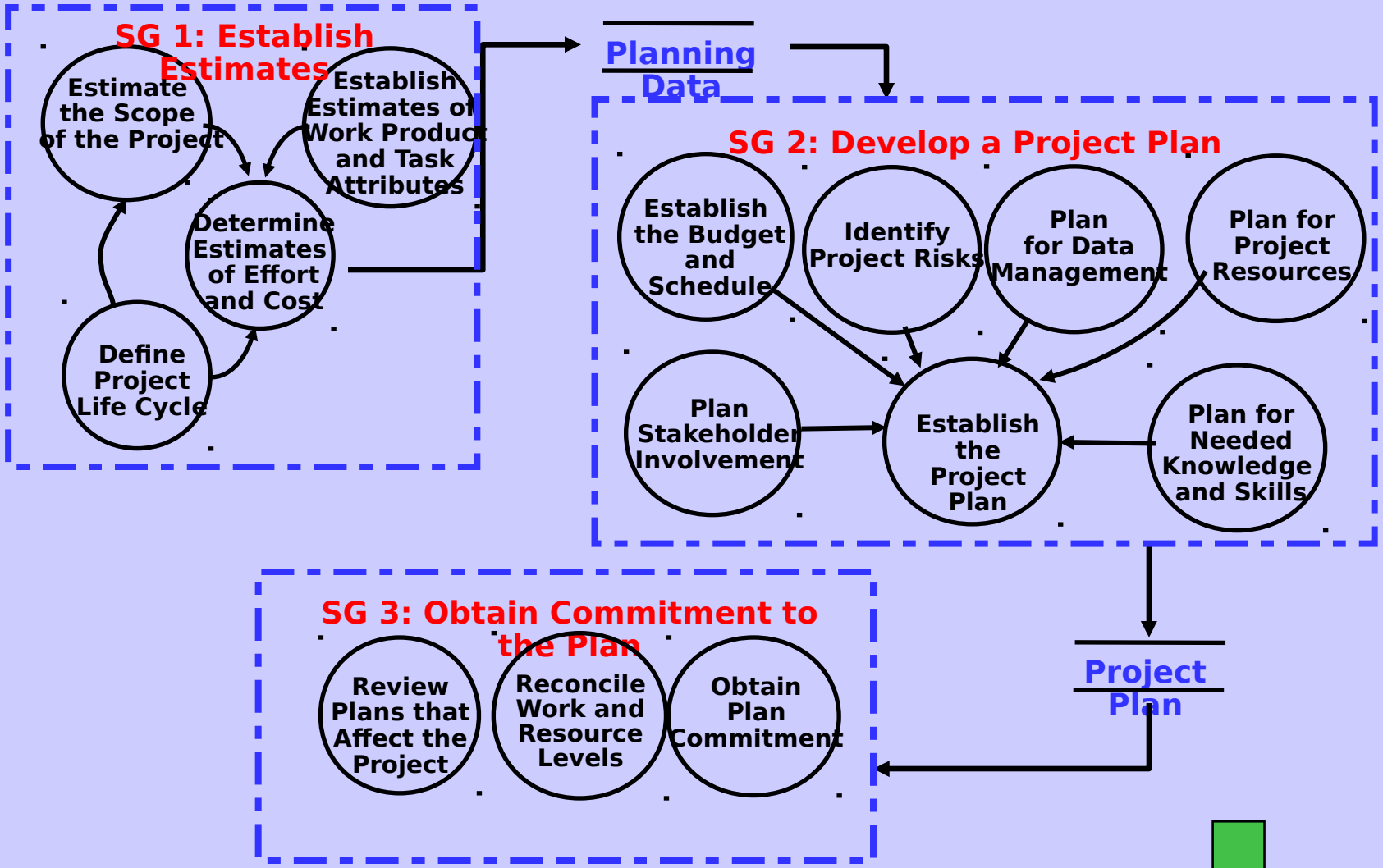
SG 1: Establish Estimates
Estimate the Scope of the Project
Establish Estimates of Work Product and Task Attributes
Determine Estimates of Effort and Cost
Define Project Life Cycle
Planning Data
SG 2: Develop a Project Plan
Establish the Budget and Schedule
Identify Project Risks
Plan for Data Management
Plan for Project Resources
Plan Stakeholder Involvement
Establish the Project Plan
Plan for Needed Knowledge and Skills
SG 3: Obtain Commitment to the Plan
Review Plans that Affect the Project
Reconcile Work and Resource Levels
Obtain Plan Commitment
Project Plan

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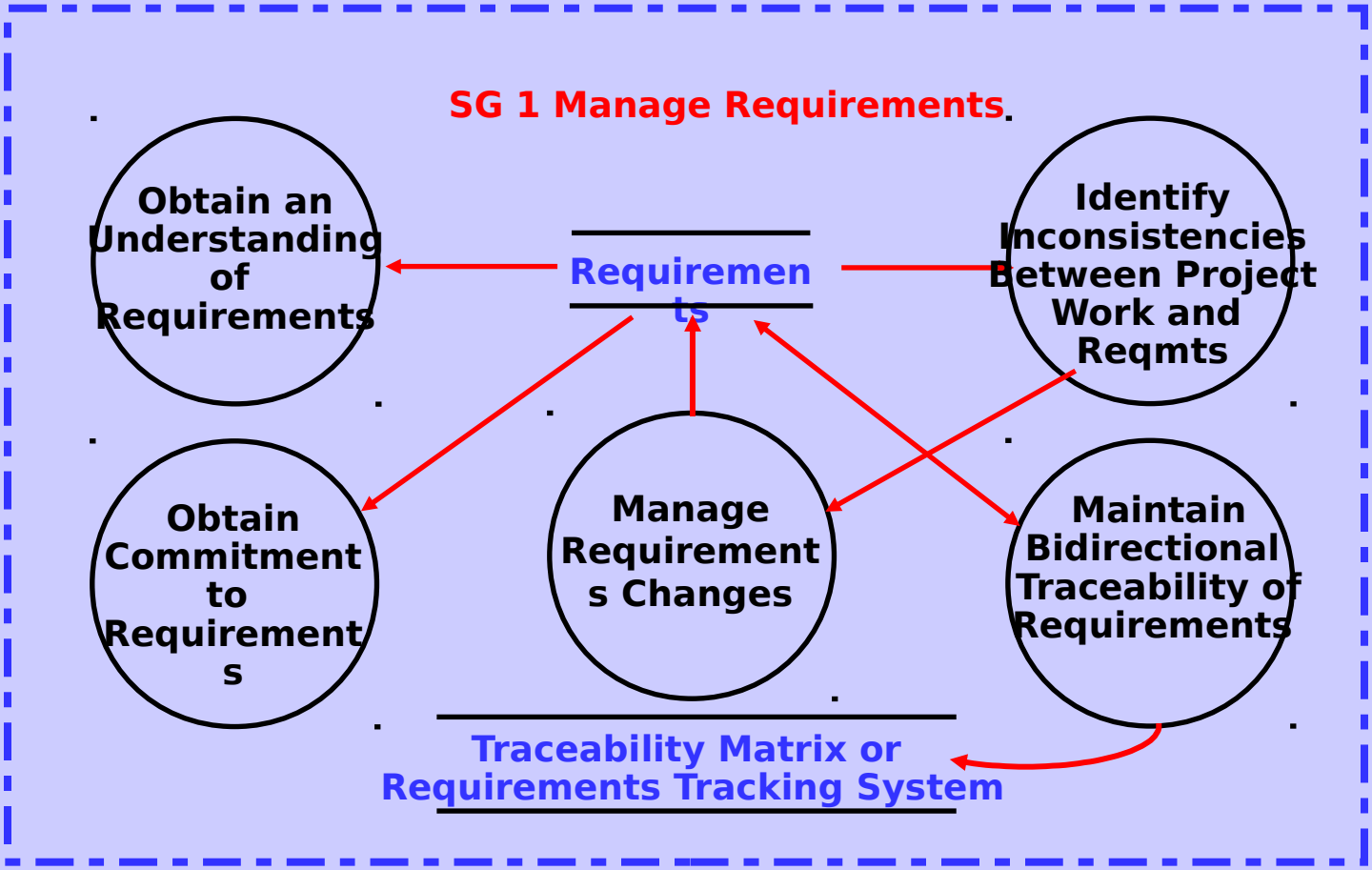
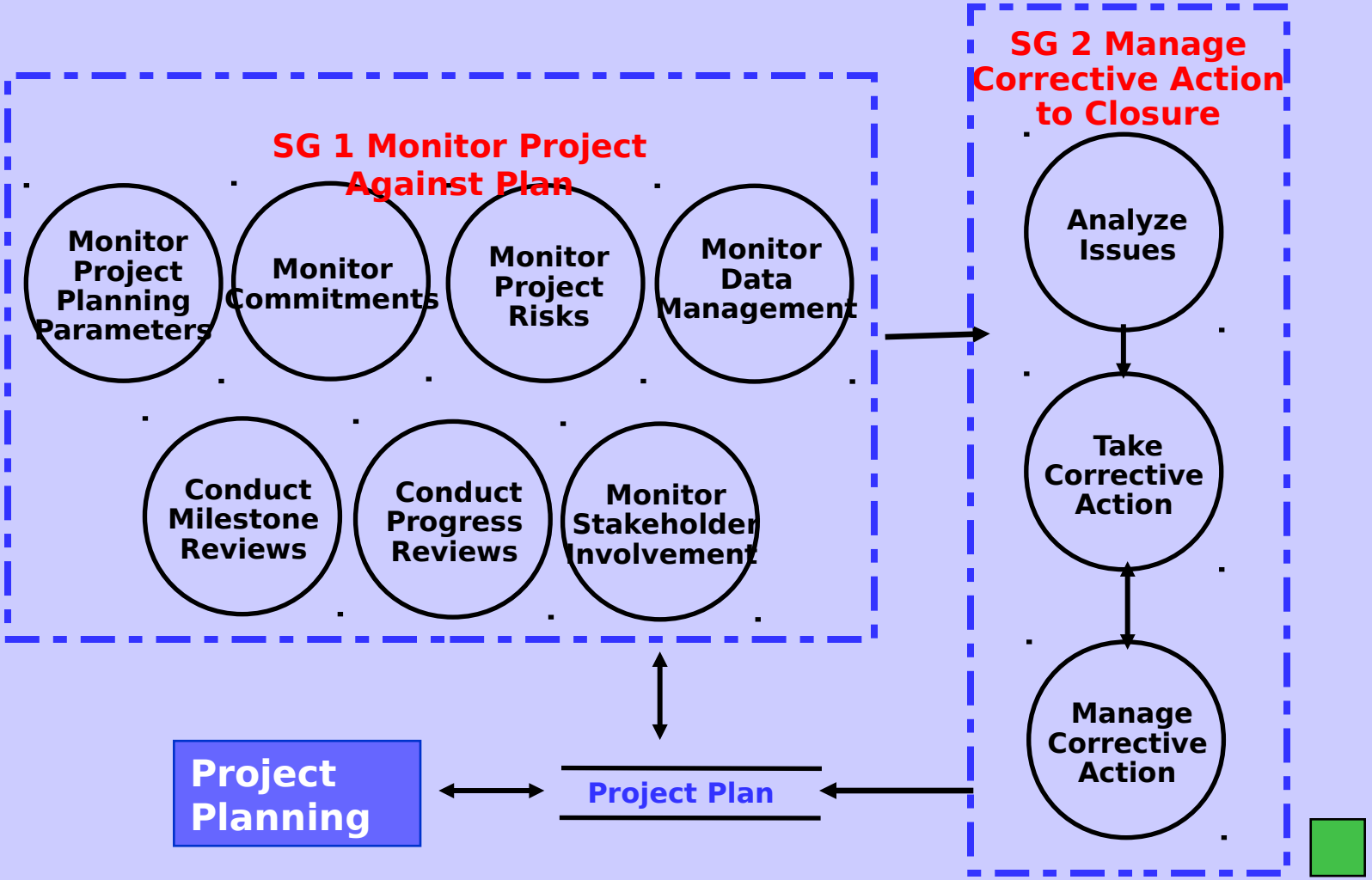
Requirements Management (RM)

PURPOSE - Manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products


SG 1 Manage Requirements
Obtain an Understanding of Requirements
Requirements
Identify Inconsistencies Between Project Work and Reqmts
Obtain Commitment to Requirements
Manage Requirements Changes
Maintain Bidirectional Traceability of Requirements
Traceability Matrix or Requirements Tracking System

Project Monitoring and Control - SGs



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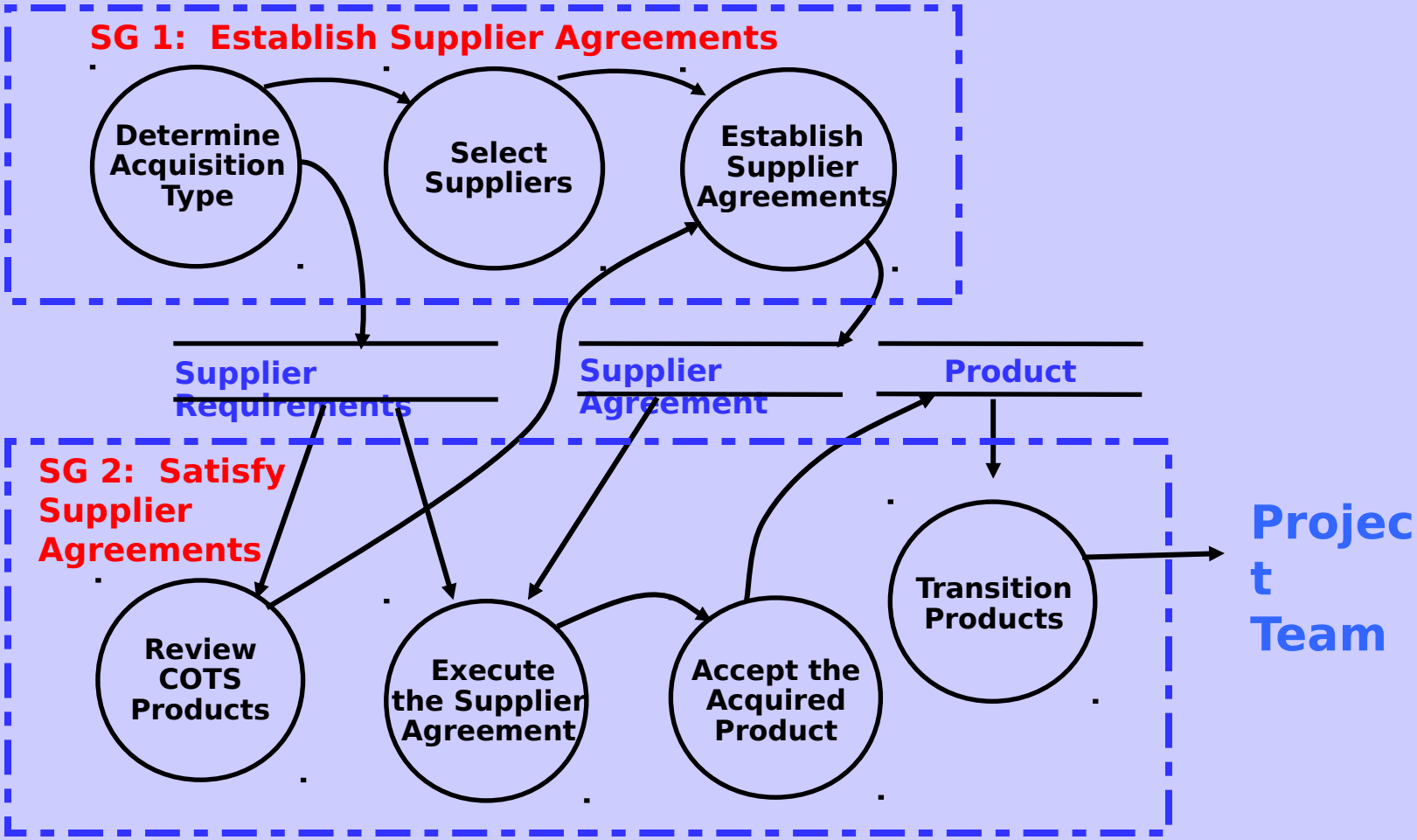
Supplier Agreement Management - SGs



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Measurement & Analysis - SGs

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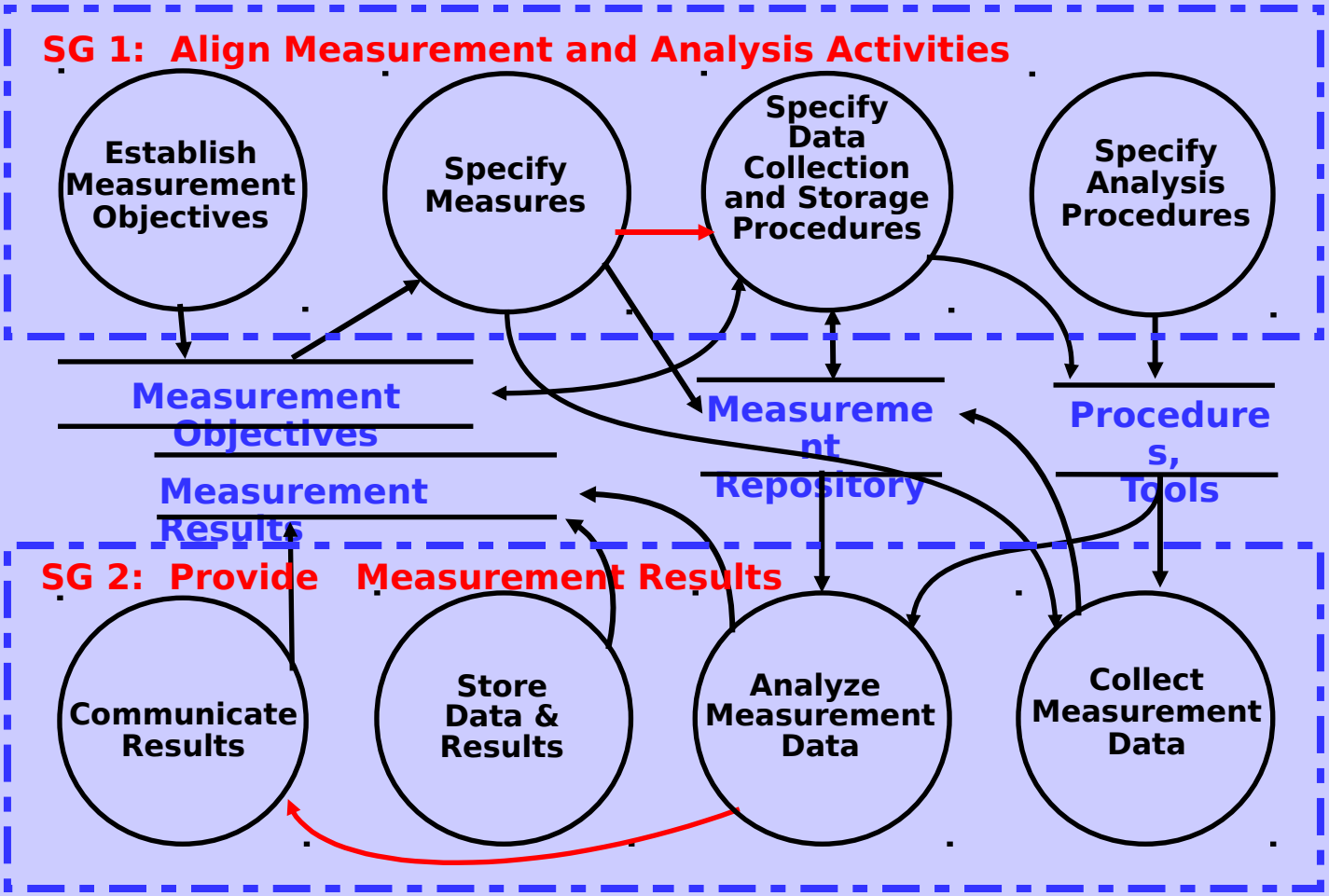

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Process and Product Quality Assurance - SGs

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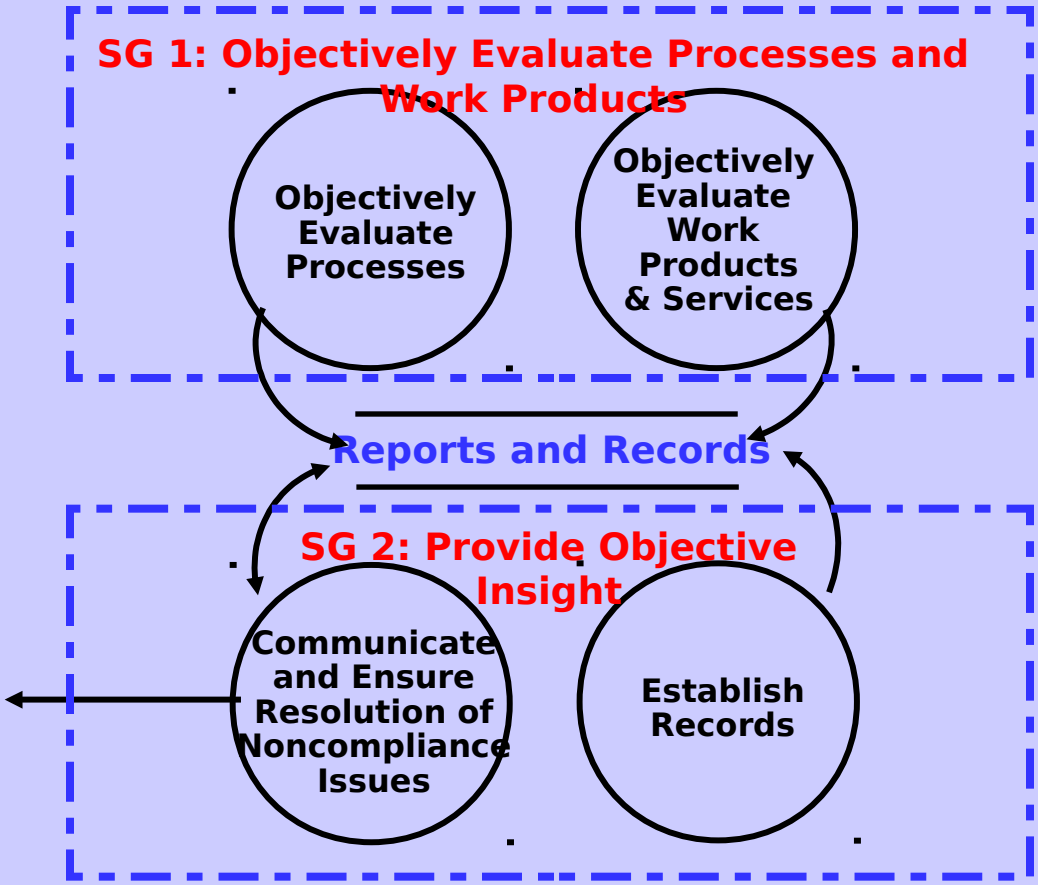
Relevant Stakeholders

- Project Manager
- Sr. Managers
- Team Members
- Other functional areas


SG 1: Objectively Evaluate Processes and Work Products
Objectively Evaluate Processes
Objectively Evaluate Work Products & Services
Reports and Records
SG 2: Provide Objective Insight
Communicate and Ensure Resolution of Noncompliance Issues
Establish Records

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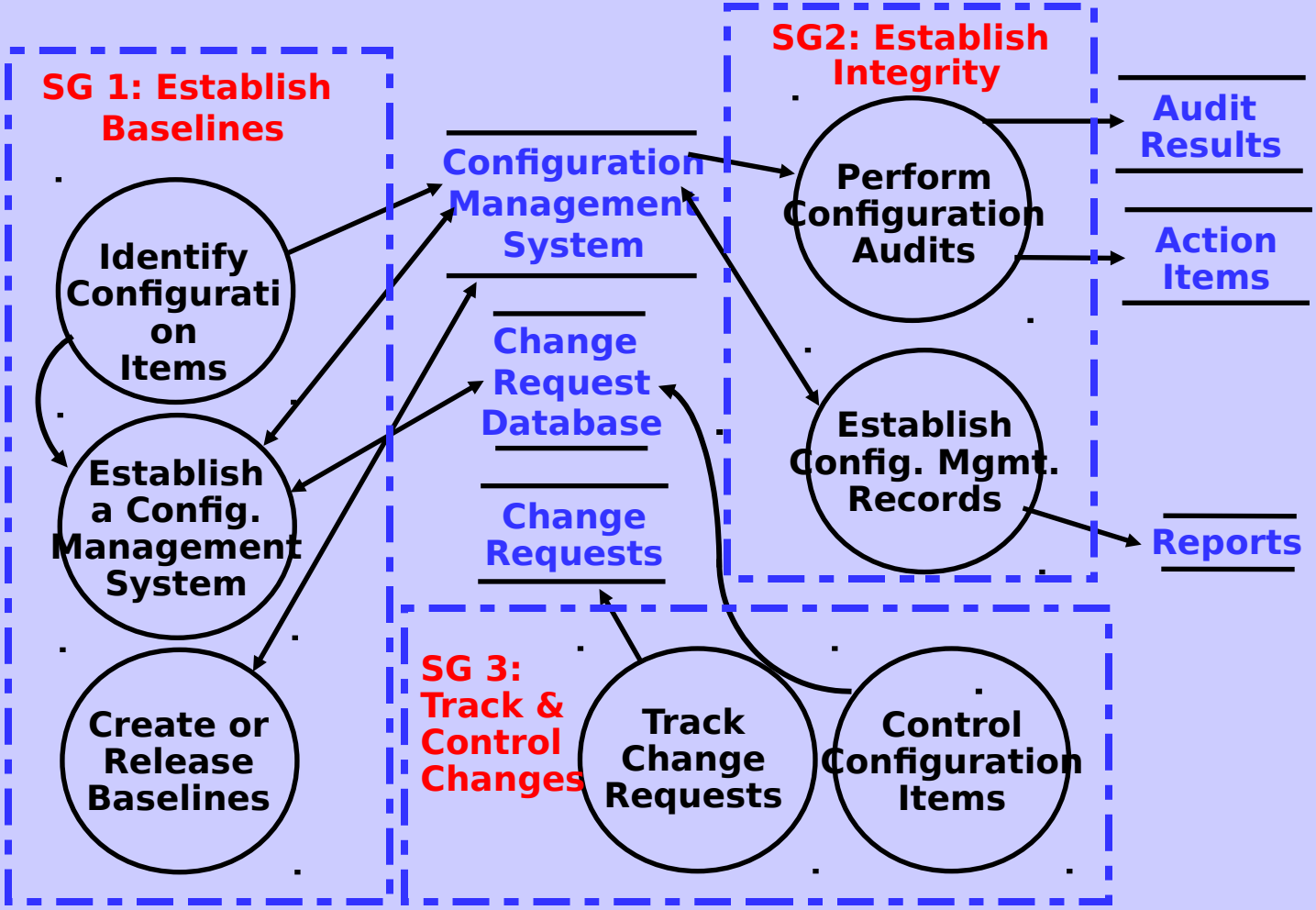
Configuration Management - SGs



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MODULE TWO
Standardized Technical Work Processes
(CMMI Maturity Level 3…and beyond!)

CMMI Level 3: the "Defined" Level - Standardizing the organization's process

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ENGINEER THE PRODUCT

- Clarify customer requirements
- Solve design requirements; develop implementation processes
- Assemble product components, deliver
- Ensure products meet requirements
- Ensure products fulfill intended use
- Analyze decisions systematically

MANAGE THE PROCESSES

- Follow integrated, defined processes
- Identify and control potential problems

PROVIDE ORG. INFRASTRUCTURE

- Establish org. responsibility for PI
- Define the org's best practices
- Develop skills and knowledge

11 Process Areas*

- *Requirements Definition (RD)*
- *Technical Solution (TS)*
- *Product Integration (PI)*
- *Verification (Ver)*
- *Validation (Val)*
- *Decision Analysis & Resolution (DAR)*
- *Integrated Project Mgmt (IPM)*
- *Risk Management (RSKM)*
- *Org. Process Focus (OPF)*
- *Org. Process Definition (OPD)*
- *Org. Training (OT)*

*SE/SW model

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Requirements Development (RD)

- Its purpose is to ***produce and analyze*** customer, product and product-component requirements
  - Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements
  - Customer requirements are refined and elaborated to develop product and product-component requirements
  - The requirements are analyzed and validated, and a definition of required functionality is developed
- Differs from Requirements Management in that RM focuses on Requirements Documentation, Change Control and Traceability, while RD:
  - Transforms the “voice of the customer” into product qualities or service functions and levels, and what will customer gain by this feature
  - Validates (based on evidence or sound footing) the requirements before going into production or servicing the customer

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Technical Solution (TS)

- Its purpose is to design, develop and implement solutions to requirements. Solutions, designs, and implementations encompass products, product components, and product-related life-cycle processes either singly or in combinations as appropriate.
  - Product or product-component solutions are selected from alternative solutions
  - Product or product-component designs are developed
  - Product components, and associated support documentation, are implemented from their designs

- Applies to:
  - Any level of the product architecture
  - To every product, product component, product-related life-cycle process, and service

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Product Integration (PI)

- Its purpose is to assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product
  - Preparation for product integration is conducted
  - The product-component interfaces, both internal and external, are compatible
  - Verified product components are assembled and the integrated, verified, and validated product is delivered
- This process area addresses:
  - Having a Plan
  - Progressively assembling product components, in one stage or in incremental stages, according to a defined integration sequence and procedures
  - Integrating product components into complete products
  - Interface management and compatibility among components

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Verification (Ver)

- The purpose of Verification is to ensure that selected work products meet their specified requirements
  - Preparation for verification is conducted
  - Peer reviews are performed on selected work products
  - Selected work products are verified against their specified requirements
- Methods of Verification
  - Inspections, audits and reviews
  - Peer reviews and walkthrough inspections
  - Analyses, simulations and demonstrations
  - Testing
- Examples of peer review methods include:
  - Walkthrough Inspections
  - Technical Reviews
  - Formal Inspections

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Validation (Val)

- Its purpose is to demonstrate that a product or product component fulfills its intended use when placed in its intended environment
  - Preparation for validation is conducted
  - The product or product components are validated to ensure that they are suitable for use in their intended operating environment

- Validation demonstrates:
  - ***The product, will fulfill its intended use in it's intended environment***
  - "You've built the right thing"

- Validation activities:
  - Use approaches similar to verification (e.g., test, analysis, inspection, demonstration, or simulation).
  - Typically includes system testing, load testing, or similar mechanisms
  - May run concurrently with verification activities
  - May use portions of same environment

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Decision Analysis and Resolution (DAR)

- The purpose of Decision Analysis and Resolution is to analyze possible decisions using a formal evaluation process that evaluates (compares) identified alternatives against established criteria
  - Decisions are based on an evaluation of alternatives using established criteria

- It involves:
  - Guidelines to determine issues which should be subjected to a formal evaluation process
  - Establishing and maintaining formal evaluation processes to address these issues
  - Determining a recommended solution based on criteria

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Integrated Project Management (IPM)

- Its purpose is to establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes
  - The project is conducted using a defined process that is tailored from the organization's set of standard processes.
  - Coordination and collaboration of the project with relevant stakeholders is conducted.
- IPM involves:
  - Establishing the ***project's defined process*** by tailoring the organization's set of standard processes
  - Managing the project using the project's defined process
  - Using and contributing to the organizational process assets
  - Enabling and ensuring relevant stakeholders:
    - Identify, consider, and address concerns during the development of the product
    - Perform their tasks in a coordinated and timely manner to:
      - Address product and product-component requirements, plans, objectives, issues, and risks
      - Fulfill their commitments
      - Identify, track, and resolve issues

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Risk Management (RskM)

- Its purpose is to identify ***potential problems before they occur,*** so that risk-handling/mitigation activities may be planned and invoked as needed
  - Preparation for risk management is conducted
  - Risks are identified and analyzed to determine their relative importance
  - Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives

- Risk Management Three phase process:
  - Defining a risk management strategy
  - Identifying and analyzing risks
  - Handling identified risks via ***risk mitigation plans*** when needed

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Organizational Process Focus (OPF)

- Its purpose is to plan and implement organizational process improvement based on a thorough understanding of the current strengths and weaknesses of the organization's processes and process assets
  - Strengths, weaknesses, and improvement opportunities for the organization's processes are identified periodically and as needed
  - Improvements are planned and implemented, organizational process assets are deployed, and process-related experiences are incorporated into the organizational process assets
- Process improvement planning and implementation includes:
  - Appraisal planning – reference model, resources, logistics, schedule and scope
  - Process action planning - result from appraisals and documents how specific improvements (identified in appraisal) will be implemented
  - Pilot planning – small scale successes before roll-out
  - Deployment planning - describes when and how the improvement will be deployed across the organization

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Organizational Process Definition (OPD)

- **The purpose of Organizational Process Definition is to establish and maintain a usable set of organizational process assets.**

- **Process assets:**
  - ***Are the collection of valued artifacts which are useful in developing, tailoring, maintaining, improving and implementing process areas across the organization***
    - **Approved policies, lifecycles and processes**
    - **Procedures, standards and guidelines**
    - **Measurement / data repositories**
    - **Best practices and tailoring guidelines**
    - **Collected templates, work products, and project data**
  - **Are developed and acquired to meet business objectives and result of investments (effort, $$, etc.)**
  - **Enable long term consistent process performance & benefits**

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Organizational Training (OT)

- **Its purpose is to develop the skills and knowledge of people so they can perform their roles effectively and efficiently**
  - **A training capability that supports the organization's management and technical roles is established and maintained**
  - **Training necessary for individuals to perform their roles effectively is provided**
- ***It includes:***
  - ***Developing a Plan***
  - ***Training to support:***
    - ***The organization's strategic business objectives***
    - ***Tactical needs that are common across projects and support groups***
- **Project and support groups are responsible for identifying and addressing their specific training needs**

CMMI Level 4: The "Quantitatively Managed" Level - Quantitative Analysis

MANAGE PROJECTS QUANTITATIVELY

- Statistically manage the project's processes and sub-processes

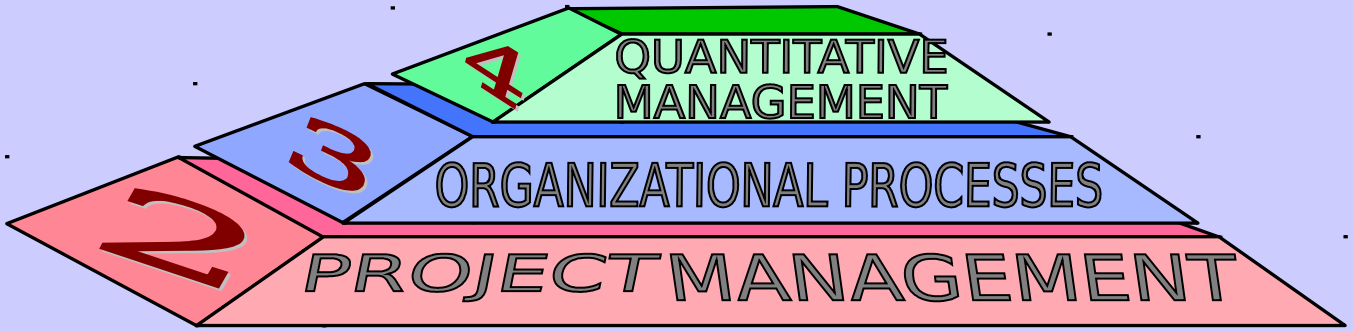
MANAGE THE ORGANIZATION QUANTITATIVELY

- Understand process performance; quantitatively manage the organization's projects

2 Process Areas

– ***Quantitative Project Management (QPM)***

– ***Organizational Process Performance (OPP)***



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CMMI Level Four Process Areas

- **Quantitative Process Management's purpose is to quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives.**
  - **The project is quantitatively managed using quality and process-performance objectives**
  - **The performance of selected sub-processes within the project's defined process is statistically managed**
- **Organization Process Performance's purpose is to establish and maintain a quantitative understanding of the performance of the organization's set of standard processes in support of quality and process-performance objectives, and to provide the process performance data, baselines, and models to quantitatively manage the organization's projects.**
  - **Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained.**

CMMI Level 5: The "Optimizing" Level - Institutionalizing Process Improvement

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CMMI

2 Process Areas

OPTIMIZE PERFORMANCE

- Identify and eliminate the cause of defects early – ***Causal Analysis and Resolution (CAR)***

ADOPT IMPROVEMENTS

- Identify and deploy new tools and process improvements to meet needs and business objectives – ***Organizational Innovation and Deployment (OID)***

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CMMI Level Five Process Areas

- **Organization Innovation and Deployment's purpose is to select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies. The improvements support the organization's quality and process-performance objectives as derived from the organization's business objectives.**
  - **Process and technology improvements that contribute to meeting quality and process-performance objectives are selected**
  - **Measurable improvements to the organization's processes and technologies are continually and systematically deployed**
- **Causal Analysis and Resolution's purpose is to identify causes of defects and other problems and take action to prevent them from occurring in the future. Root causes of defects and other problems are systematically determined and addressed to prevent their future occurrence.**

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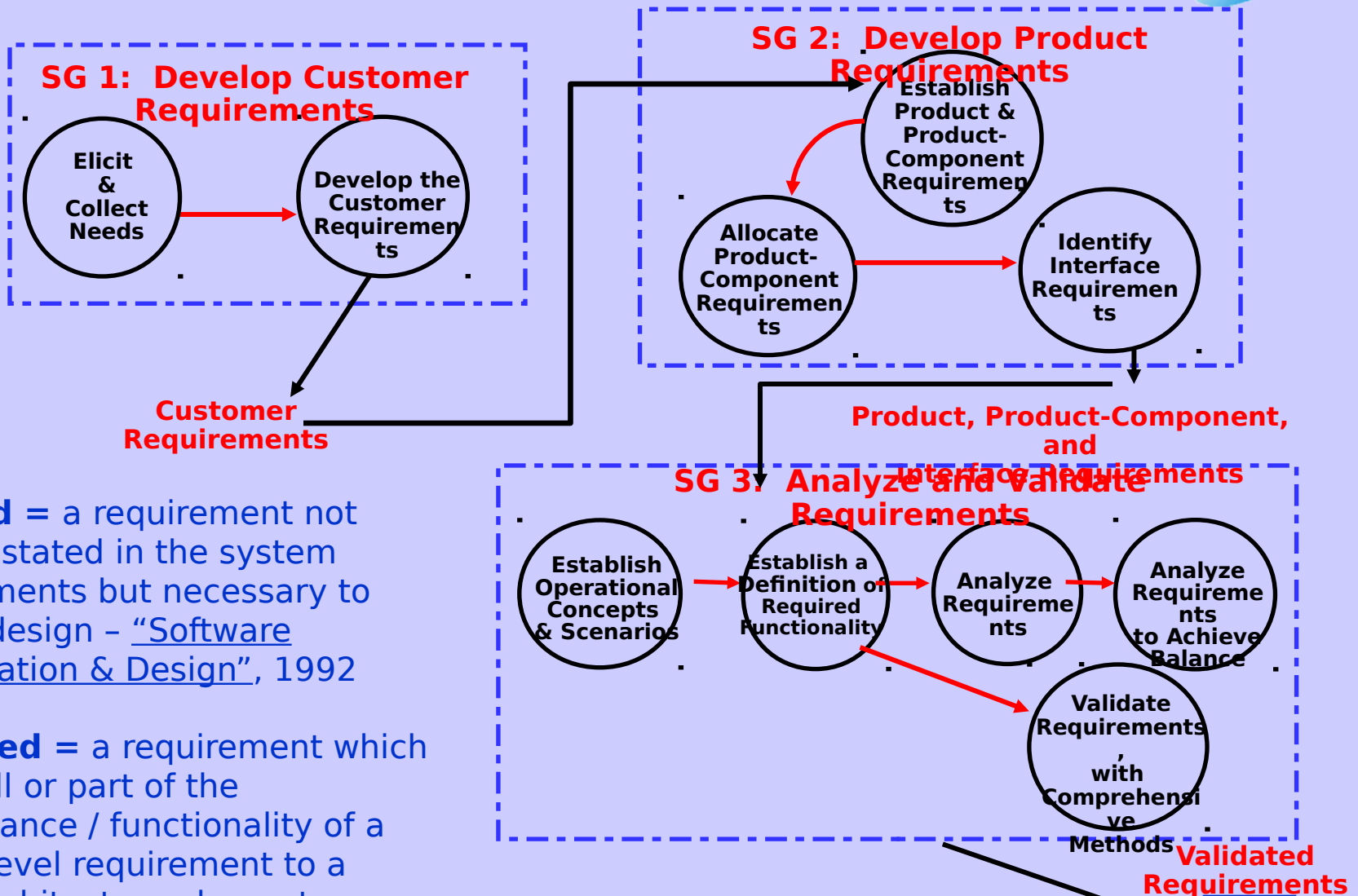
MODULE Two Backup Materials

- **CMMI Level 3 Process Area Flow Diagrams**

Requirements Development - SGs


SG 1: Develop Customer Requirements
Elicit & Collect Needs
Develop the Customer Requirements
Customer Requirements
SG 2: Develop Product Requirements
Establish Product & Product-Component Requirements
Allocate Product-Component Requirements
Identify Interface Requirements
Product, Product-Component, and Interface Requirements
SG 3: Analyze and Validate Requirements
Establish Operational Concepts & Scenarios
Establish a Definition of Required Functionality
Analyze Requirements
Analyze Requirements to Achieve Balance
Validate Requirements, with Comprehensive Methods
Validated Requirements

Derived = a requirement not directly stated in the system requirements but necessary to satisfy design – "Software Specification & Design", 1992

Allocated = a requirement which levies all or part of the performance / functionality of a higher level requirement to a lower architecture element or design component - CMMI Glossary

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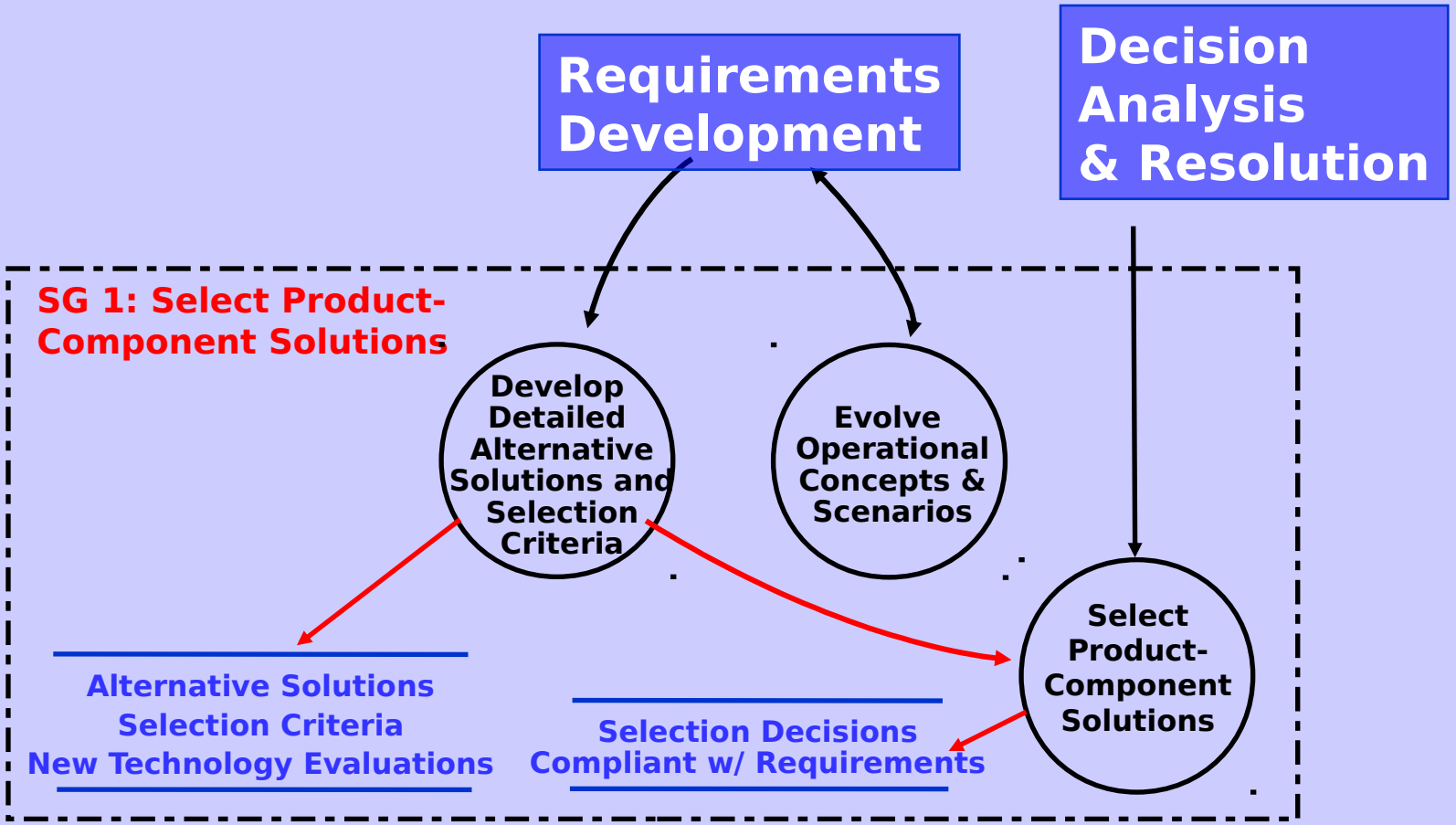
Technical Solution - SGs

CMMI®



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Technical Solution - SGs

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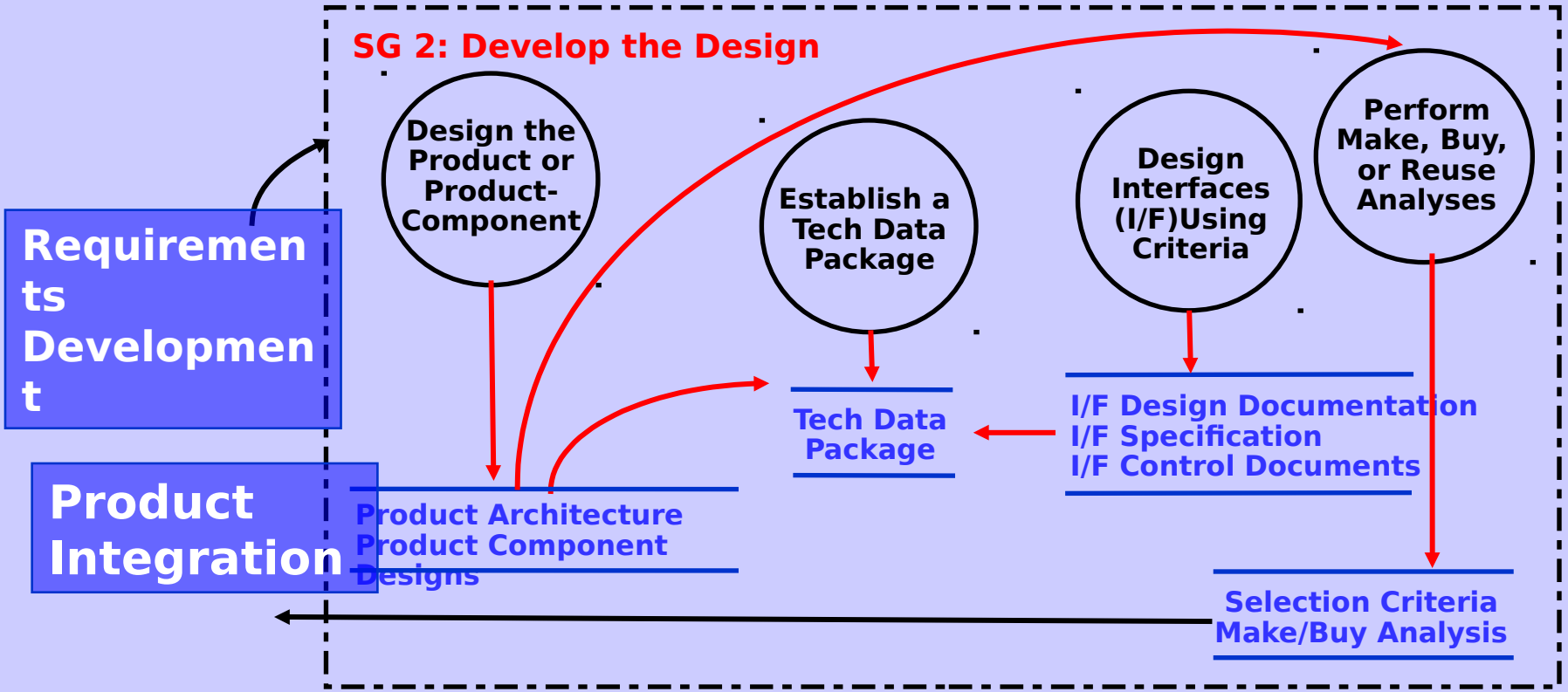

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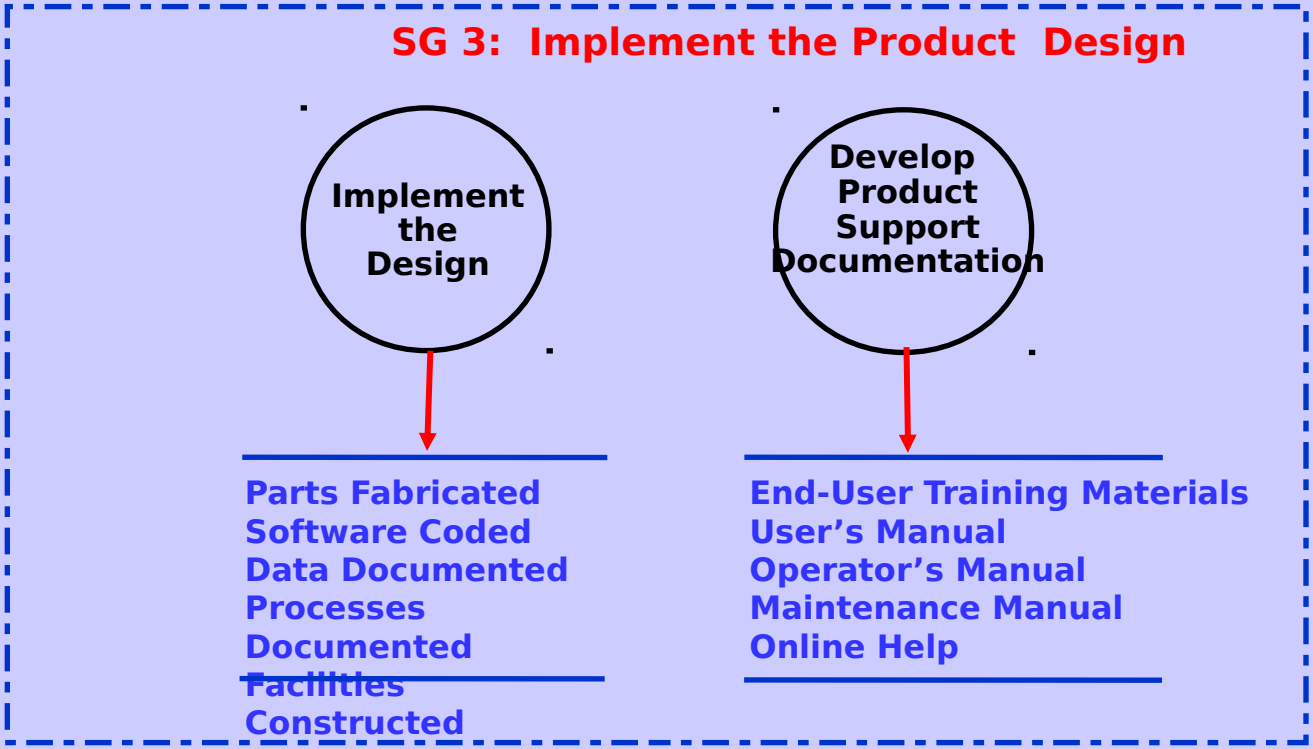
Technical Solution - SGs



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Product Integration - SGs

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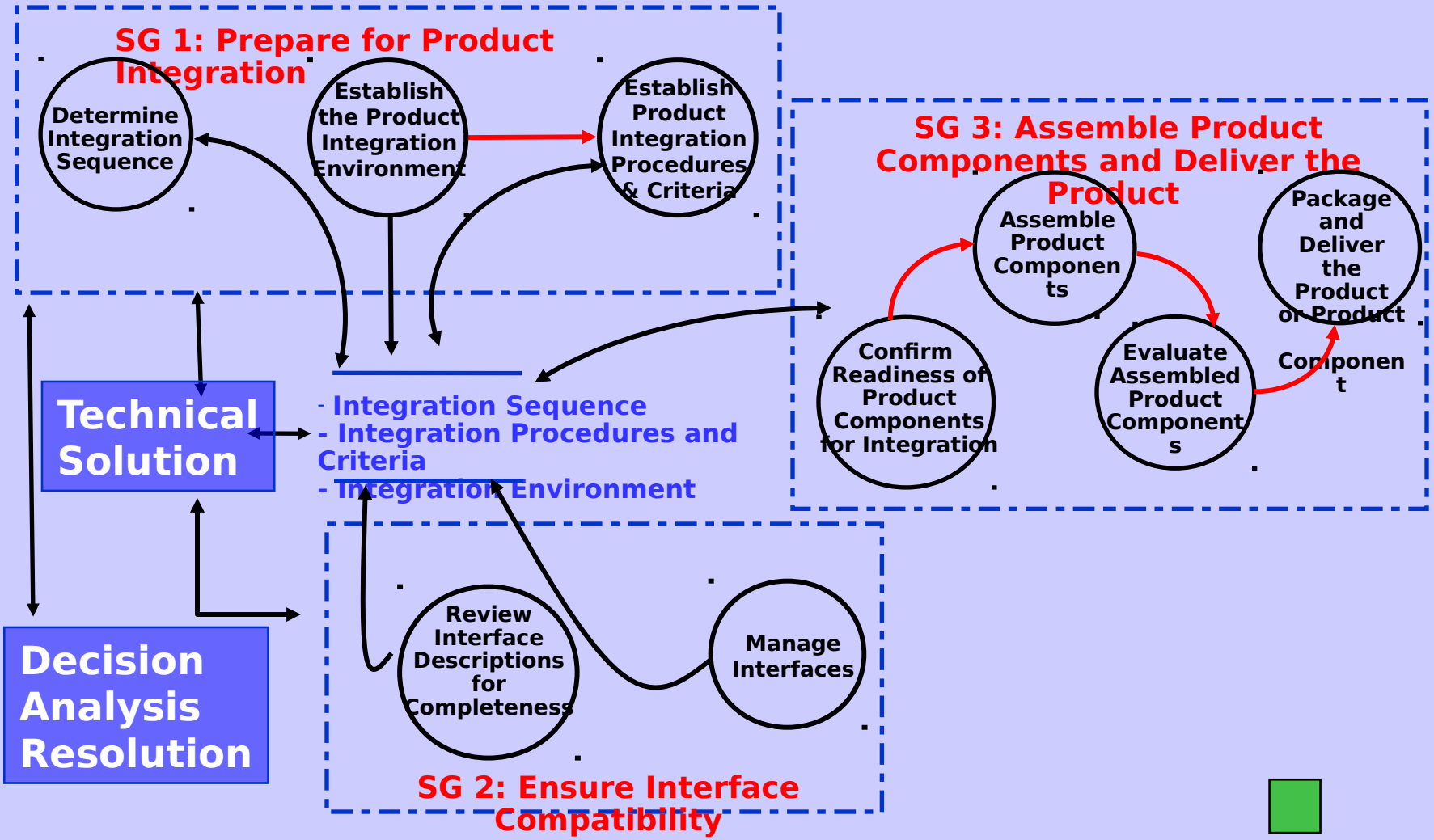
SG 1: Prepare for Product Integration
Determine Integration Sequence
Establish the Product Integration Environment
Establish Product Integration Procedures & Criteria
SG 3: Assemble Product Components and Deliver the Product
Assemble Product Components
Package and Deliver the Product or Product Component
Confirm Readiness of Product Components for Integration
Evaluate Assembled Product Components
- Integration Sequence
- Integration Procedures and Criteria
- Integration Environment
Technical Solution
Decision Analysis Resolution
Review Interface Descriptions for Completeness
Manage Interfaces
SG 2: Ensure Interface Compatibility

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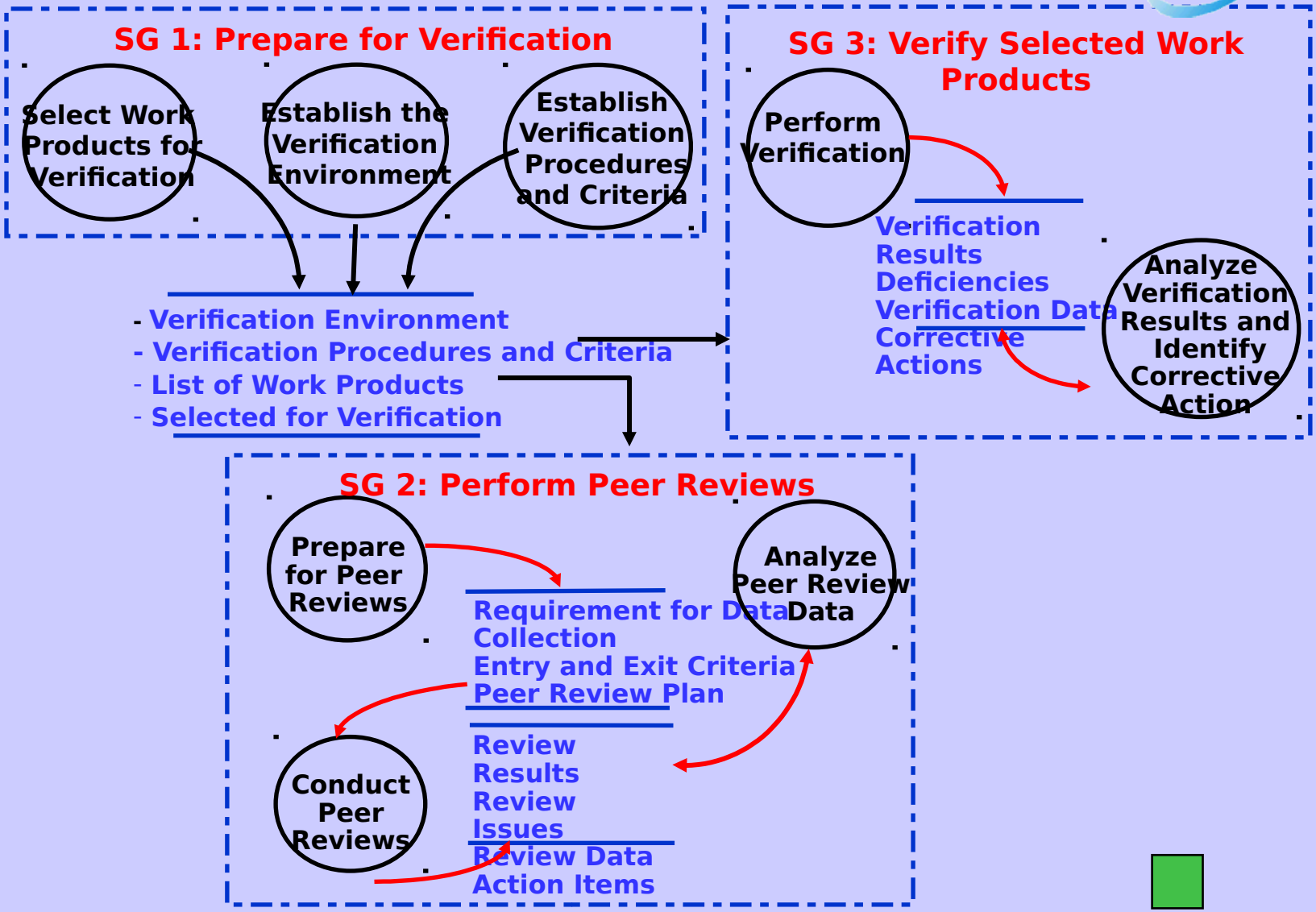
Verification - SGs



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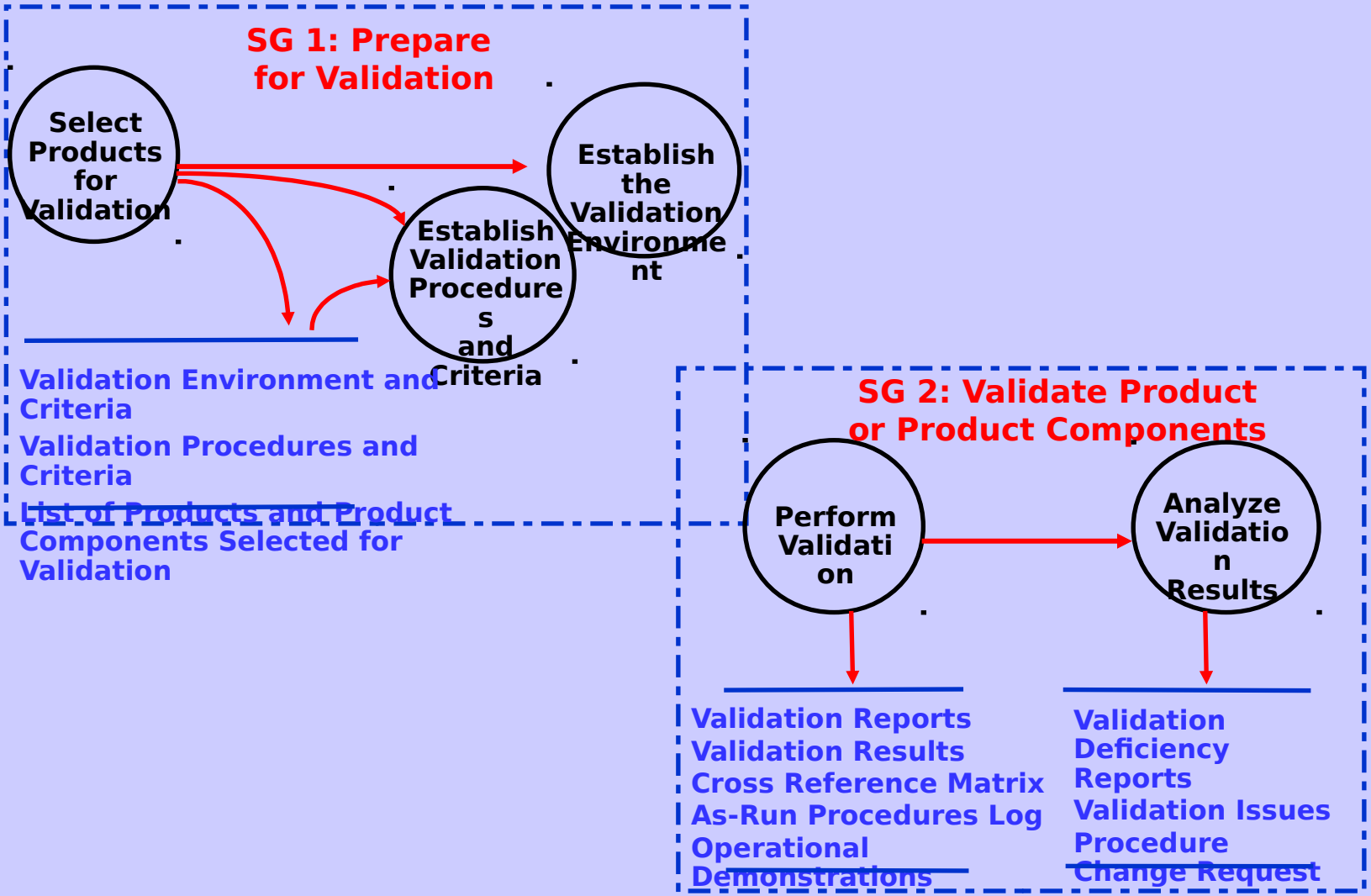
Validation-SGs



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Decision Analysis and Resolution - SG

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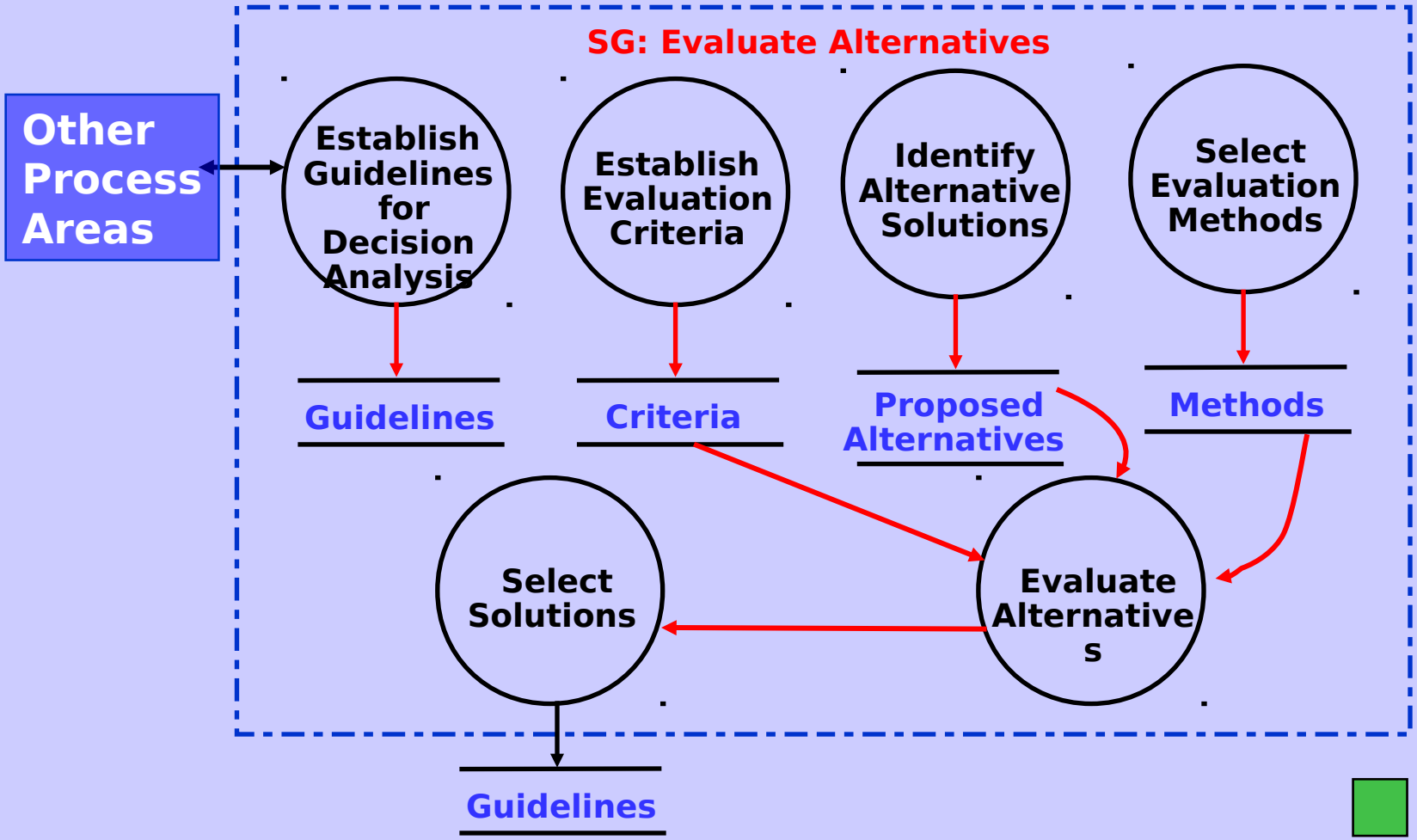

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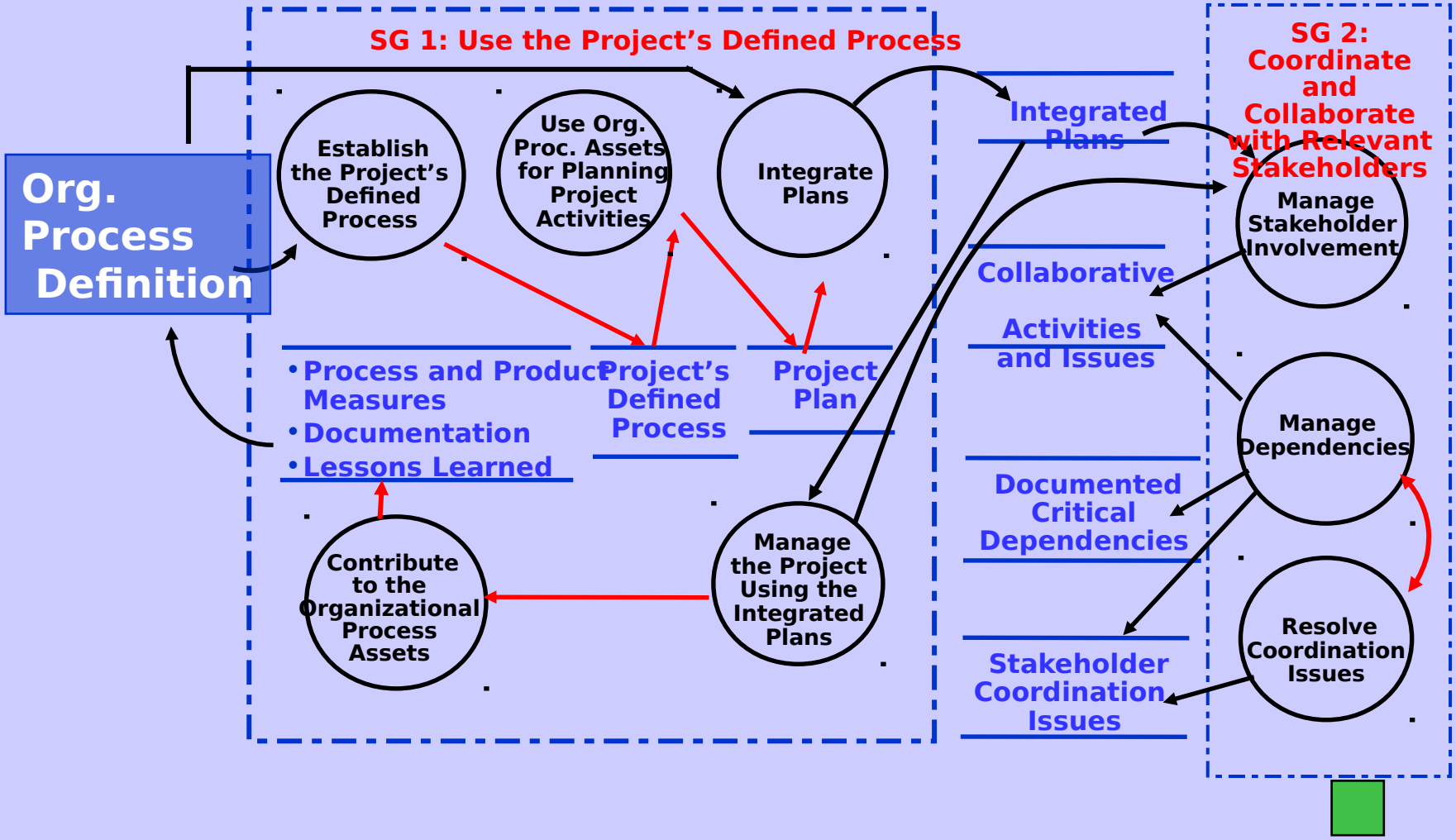
Integrated Project Management - SGs



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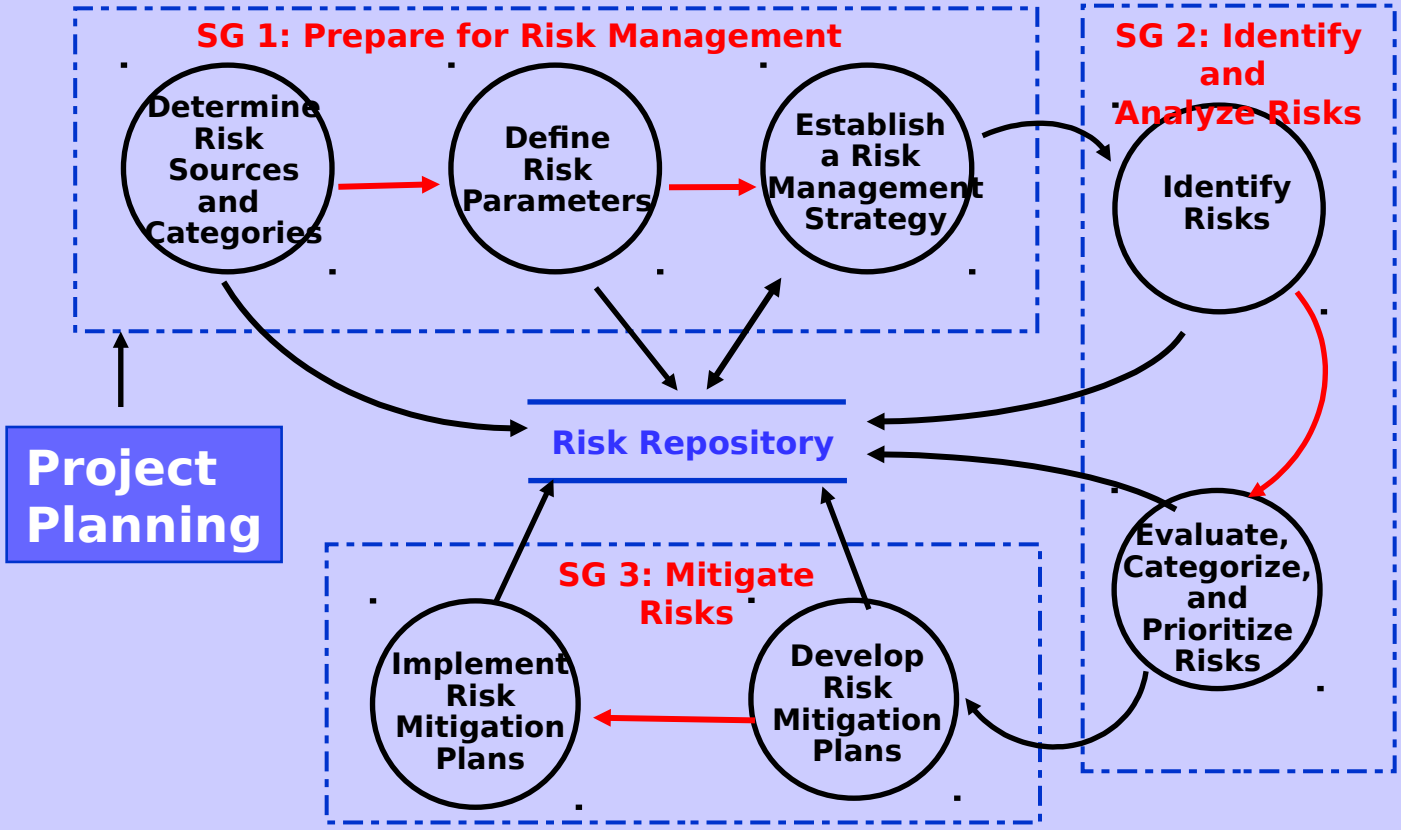
Risk Management - SGs


SG 1: Prepare for Risk Management
Determine Risk Sources and Categories
Define Risk Parameters
Establish a Risk Management Strategy
SG 2: Identify and Analyze Risks
Identify Risks
Evaluate, Categorize, and Prioritize Risks
Risk Repository
Project Planning
SG 3: Mitigate Risks
Implement Risk Mitigation Plans
Develop Risk Mitigation Plans

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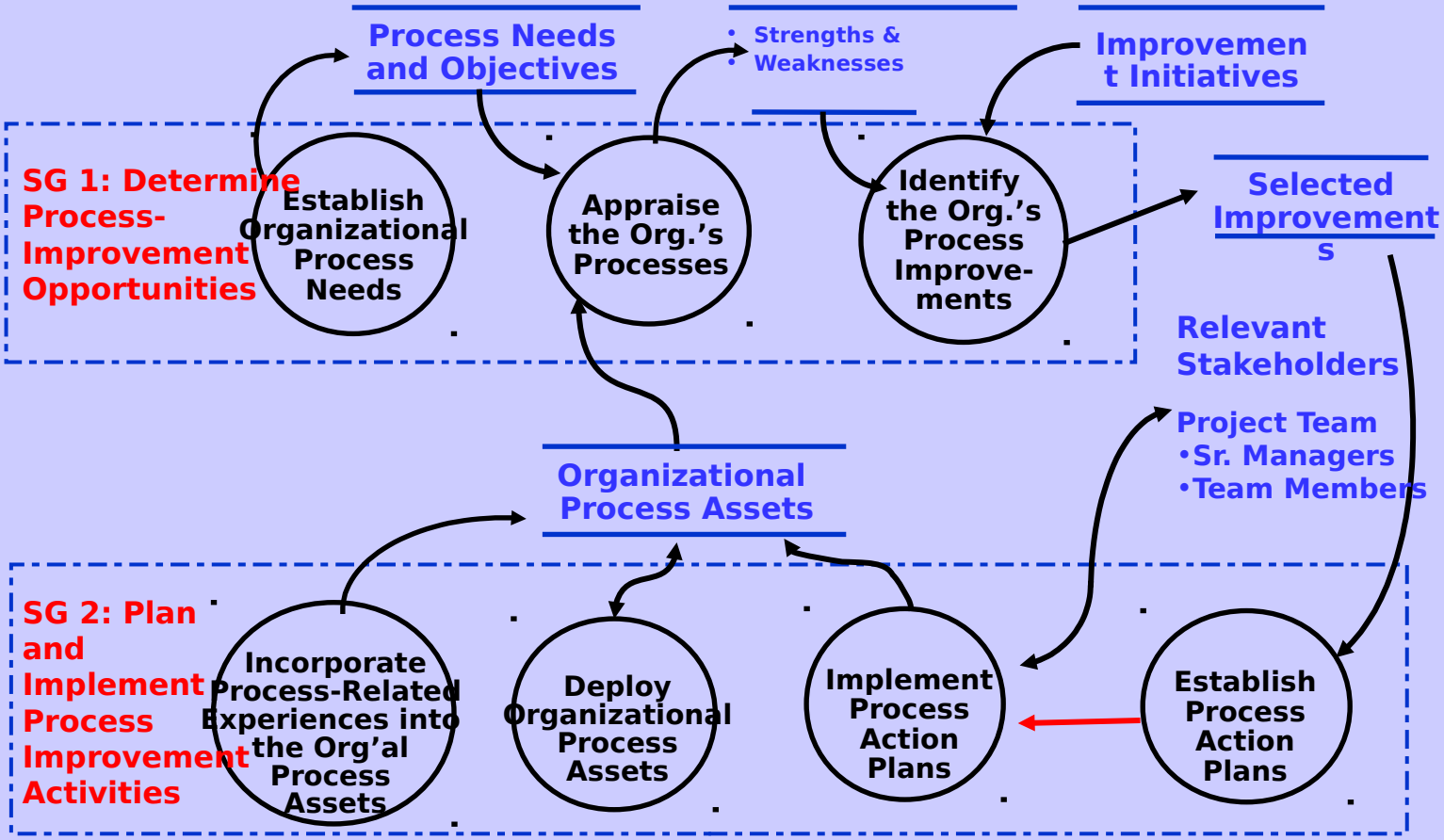
Organizational Process Focus - SGs



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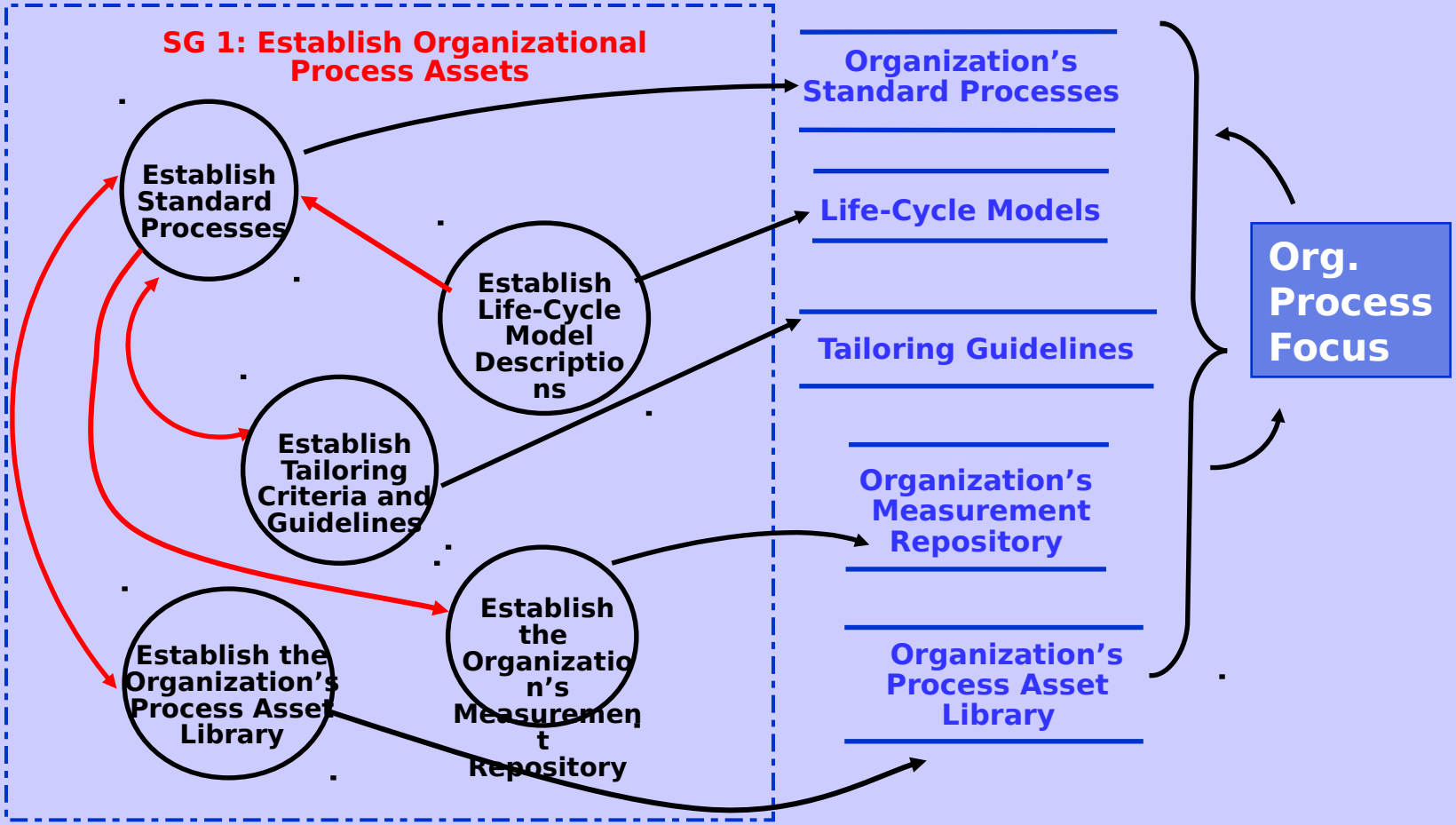
Organizational Process Definition - SGs



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Organizational Training - SGs

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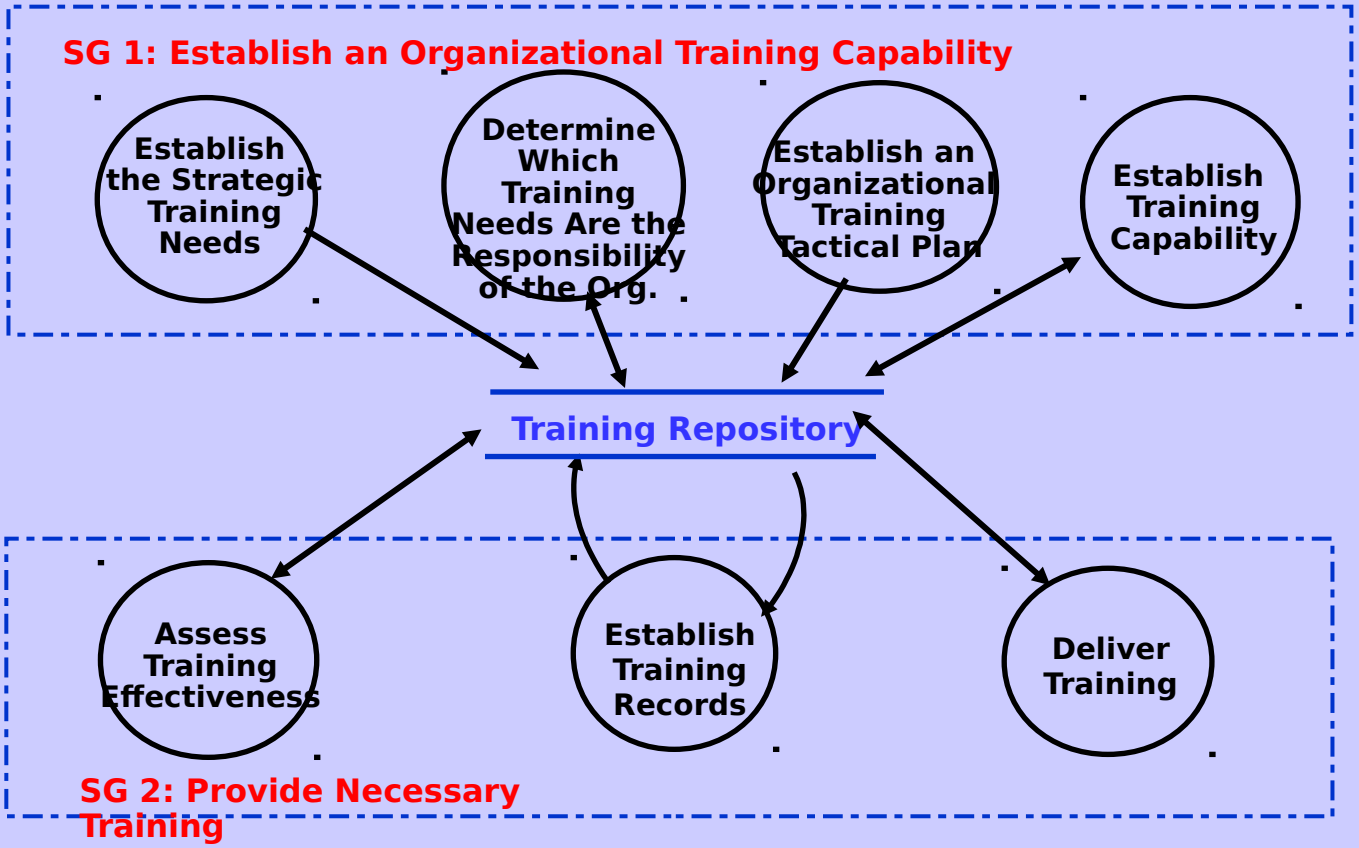
SG 1: Establish an Organizational Training Capability
Establish the Strategic Training Needs
Determine Which Training Needs Are the Responsibility of the Org.
Establish an Organizational Training Tactical Plan
Establish Training Capability
Training Repository
Assess Training Effectiveness
Establish Training Records
Deliver Training
SG 2: Provide Necessary Training

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MODULE THREE
SO HOW DO WE DO THIS?

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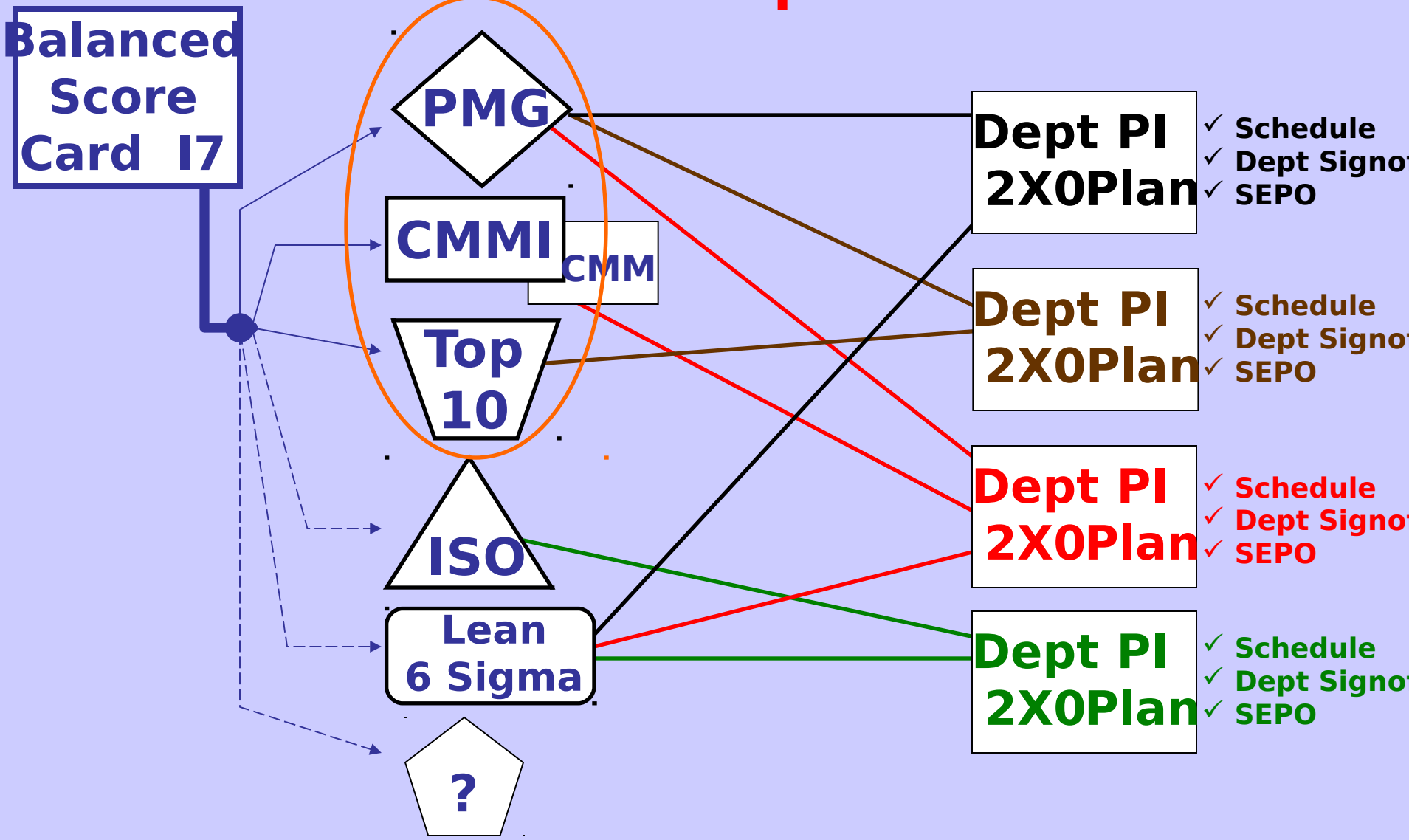
I7 Mapping: Process Improvement Initiatives to Departments



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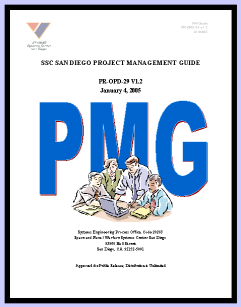
SSC San Diego's Implementation Approach…

Project Management Policy and System / Software Engineering Management Policy (Draft)

Implemented by

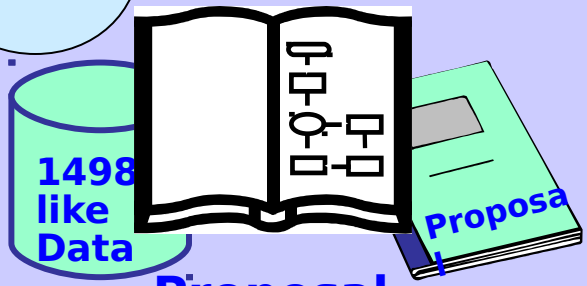
Project Management Guide, & project best practices

supported by



- **CMMI**
- **PMBOK**

PM Website



Proposal Preparation Guide

Project Mgt Plan, procedures, templates and project examples and best practices

Basic PM Guidelines (Job Description)

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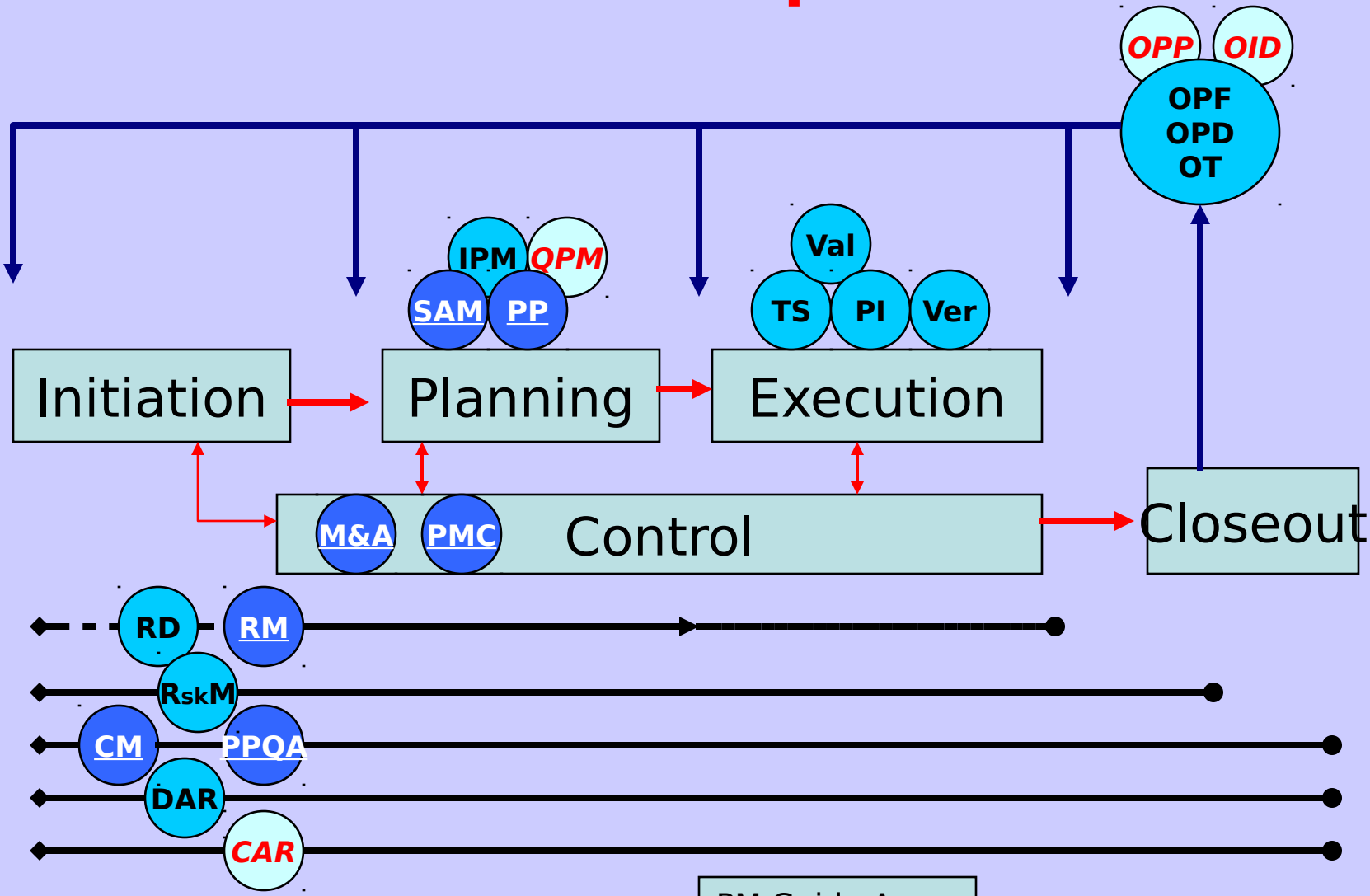
PMG and CMMI Synergy
A Road Map



PM & Engineering Elements Associations between CMMI & PMG

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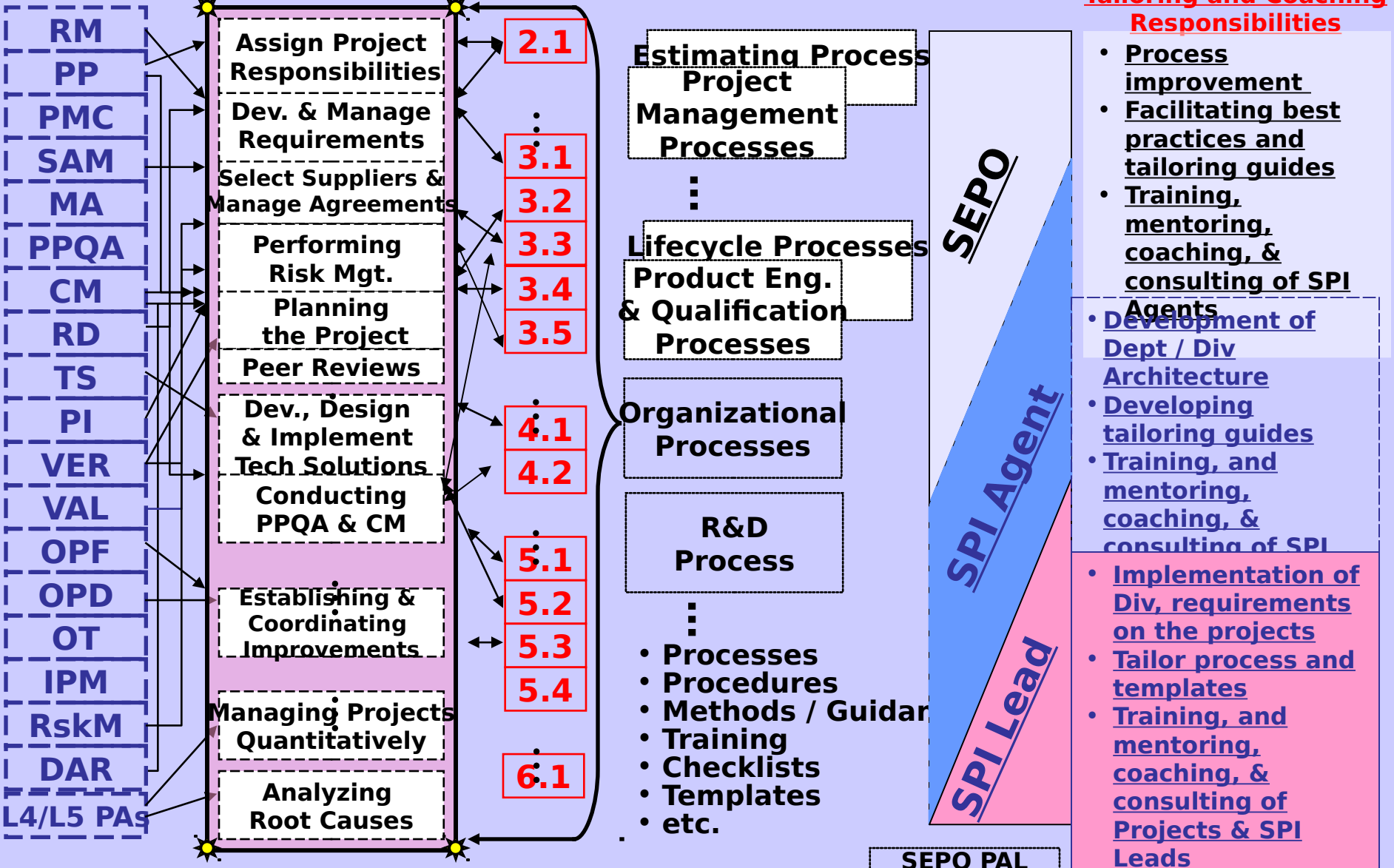

Tailoring and Coaching Responsibilities

- Process improvement
- Facilitating best practices and tailoring guides
- Training, mentoring, coaching, & consulting of SPI Agents

- Development of Dept / Div Architecture
- Developing tailoring guides
- Training, and mentoring, coaching, & consulting of SPI

- Implementation of Div, requirements on the projects
- Tailor process and templates
- Training, and mentoring, coaching, & consulting of Projects & SPI Leads

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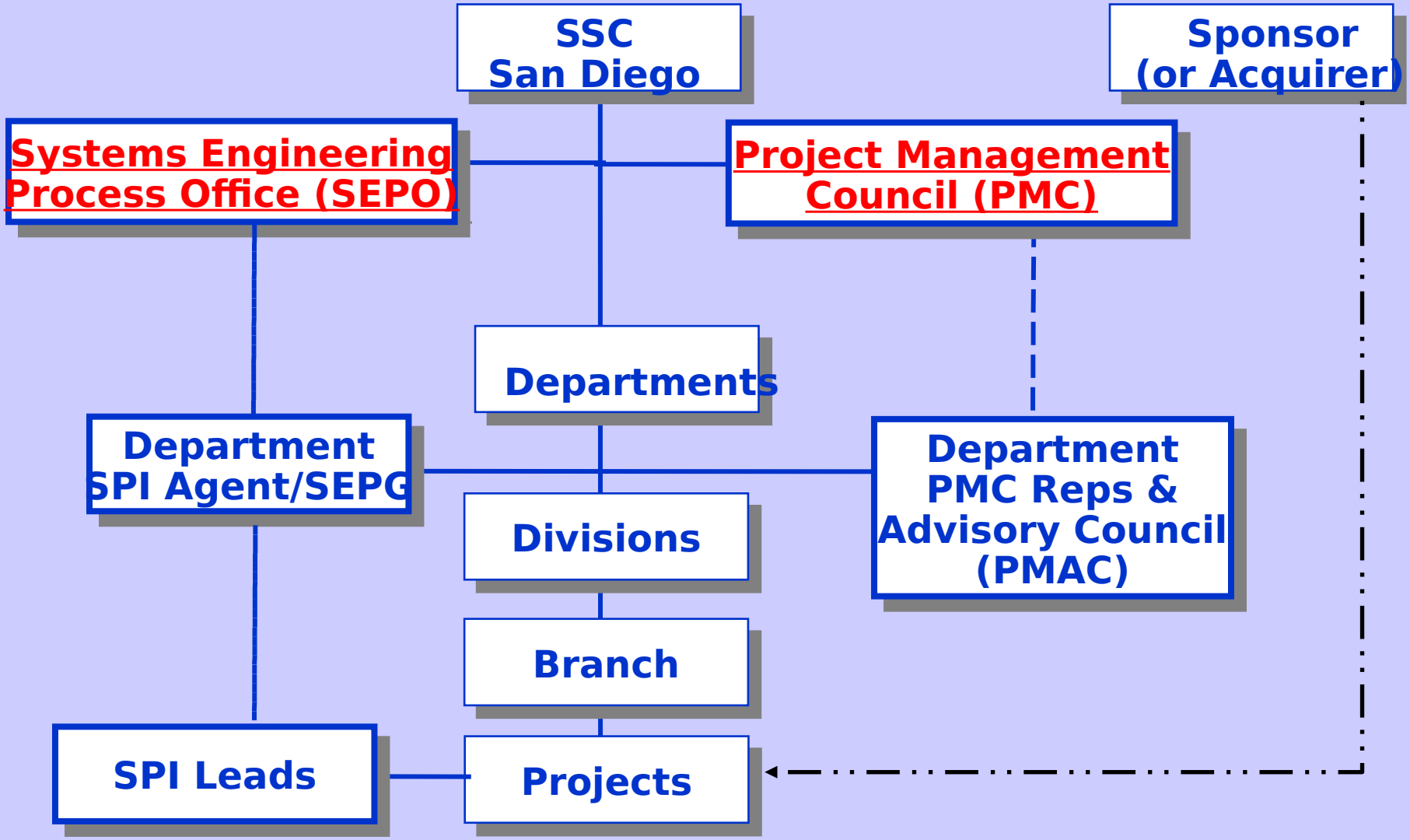
Best Practices Support - Organizational View



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SSC San Diego's Systems Engineering Process Office (SEPO Code 20203)

- **Maintains SSC San Diego's Process Asset Library (PAL): Comprehensive web page of process improvement material at http://sepo.spawar.navy.mil/**
- **Facilitates process improvement across all of SSC San Diego**
- **Trains PMs and facilitates the implementation of the Project Management Guide**
- **Develops and maintains a variety of engineering and management training courses**
- **Assists with internal appraisals on projects to determine best practices and areas for improvement**
- **Maintains Software Community Alias: Email alias with over 800 members for announcements, requests for assistance**
- **Facilitates Systems Process Improvement Working Group (SPIWG): periodic meetings, seminars, lectures, debates, demos about systems engineering and process improvement issues**
- **Maintains SEPO Library: process improvement related books, guidelines, standards, products, processes, publications, proceedings, articles, videos**
- **Performs Community Liaison: Interface with the process improvement community outside of SSC San Diego, both government and commercial**

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SSC San Diego Organizational PAL

http://sepo.spawar.navy.mil/

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Using the Enterprise Level As A Start For Information Exchange & Improvement

Enterprise (SEPO)

Processes & Templates
-PE&Q -SDP / PMP
-EPD -CMP -PI Plan
-PMG -QAP -Task Mgt
-IV&V -SEPO

Resources
-Library
-SPIWGs
-PAL
-Measurement Repository

Training
-PMCC
-Intro. To BPs
-Peer Review
-Workshops

Policies and Standards
-PMG -PM Policy
-IEEE / ISO -SEM Policy
-MIL-STDs -EVM Policy
-Comm STDs

New or Tailored Processes, Templates, and Best Practices For Dept. or Business Needs

Organization (e.g. Dept)

Project Plans
-PMP
-CMP
-QAP

Tailored Policies & Standards

Project Processes & Procedures

Project Work Products

Trained Personnel

Projects

What CMMI Level 3 Behavior Looks Like

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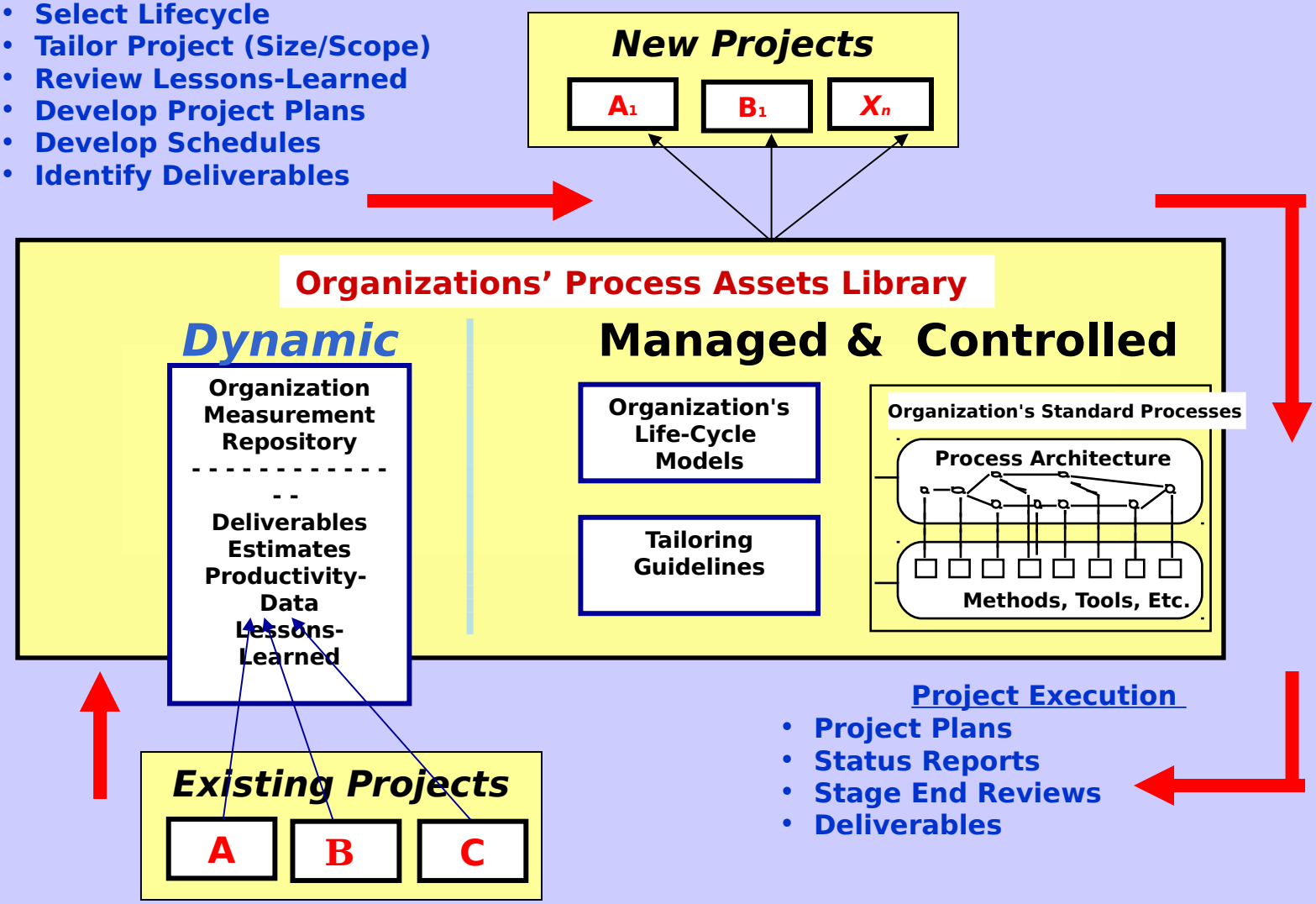
CMMI

Project Planning

- Assign Project Manager
- Select Lifecycle
- Tailor Project (Size/Scope)
- Review Lessons-Learned
- Develop Project Plans
- Develop Schedules
- Identify Deliverables



Project Execution

- Project Plans
- Status Reports
- Stage End Reviews
- Deliverables

Adapted from CMU/SEI TR-25, page O-52

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What do I do ?

- **Management must be involved. You can't delegate a 'Shrink-Wrapped' solution - *maturity is a function of Project Behavior.***
- **Hold all levels of managers responsible for results under their cognizance. SEPO is responsible for the care, not the use, of organization's assets. *Institutionalization is the responsibility of the project managers and their direct supervisors!***
- **Train from the top down – *Management at all levels must share the common goal.***
- ***Quantified periodic progress reviews mandatory* - on Process Improvement Participation *and* Corporate Goals**

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CMMI Implementation – A Plan of Action for PMs

- **Step One:** Identify your Department SPI Agent
- **Step Two:** Appoint a Project-level SPI Lead
- **Step Three:** Have the Project SPI Lead, with the assistance of the PM, Department SPI Agent(s), and the SEPO Department liaison, develop a Process Improvement Plan, a strategy for implementing CMMI (templates available on the SEPO PAL)
- **Step Four:** Establish goals and objectives for CMMI Implementation based on your determination of needs, "pain points", resources (e.g. implement Configuration Management first by [insert date], then implement Requirements Management by [insert date], etc.)
- **Step Five:** Set up, with the Department SPI Agent, a sequence of Implementation Status Reviews (based on your estimated schedule, monthly or quarterly reviews may be appropriate) with the Department
- **Step Six:** TACAMO (Take Charge and Move Out!)

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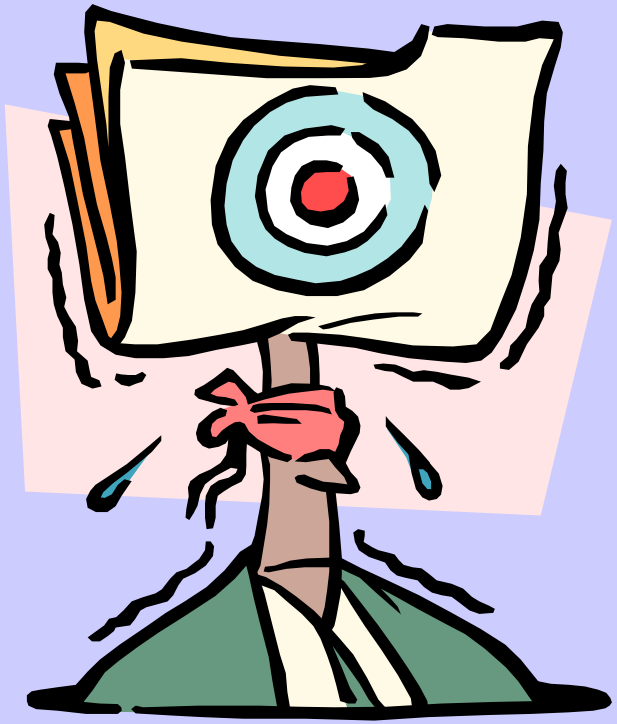
QUESTIONS ?



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CMMI – More Information

- CMMI Process Maturity Profile
- CMMI Advocates, AKA “The Competition”
- Best Practices Save Money
- Benefits of Implementing Best Practices
- How Capability Maturity Level is Determined
- CMM Process Maturity Profile of S/W Community
- Continuous Representation
- Process Capability
- How do I build the Infrastructure - Process Institutionalization and Advancing Maturity

CMMI Process Maturity Profile for Systems & Software Community

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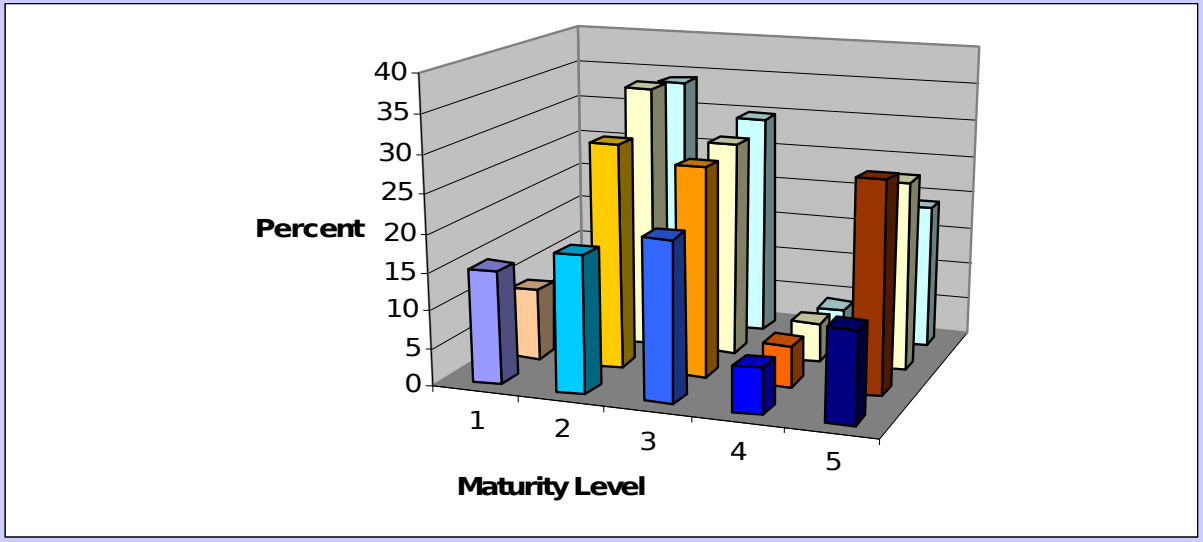
Maturity Level	Feb 2003	Mar 2004	Aug 2004	SEP2005
1- Initial	15%	9.5%	6.3%	3.5%
2- Managed	18%	29.7%	35.1%	34.1%
3- Defined	21%	27.7%	28.5%	29.7%
4- Quantitatively Managed	6%	5.4%	5.2%	4%
5- Optimizing	12%	27.7%	25.0%	19.2%
Organizations reporting to SEI	33	148	288	782



Source: http://www.sei.cmu.edu/sema/profile.html

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CMM and CMMI Advocates – AKA "The Competition"

Organizations at CMM or CMMI Level 4 or 5

Boeing	CSC Defense Group	Honeywell	
Hughes	Litton	Lockheed Martin	
Motorola	NCR	Northrop Grumman	
Raytheon	United Space Alliance	USAF Hill AFB	
USAF Tinker AFB	USA CECOM	USN FMSO	
NAWC China Lake	NSWC PHD (Dam Neck)		SAIC
BAE Rancho Bernardo		IBM	NASA Shuttle
	USA Fort Sill		

CMMI Sources:

- CMMI Softcopy:
  http://www.sei.cmu.edu/cmmi/models/models.html
- Transitioning to CMMI – A Guide for Executives
  http://www.sei.cmu.edu/cmmi/publications/exec.pdf

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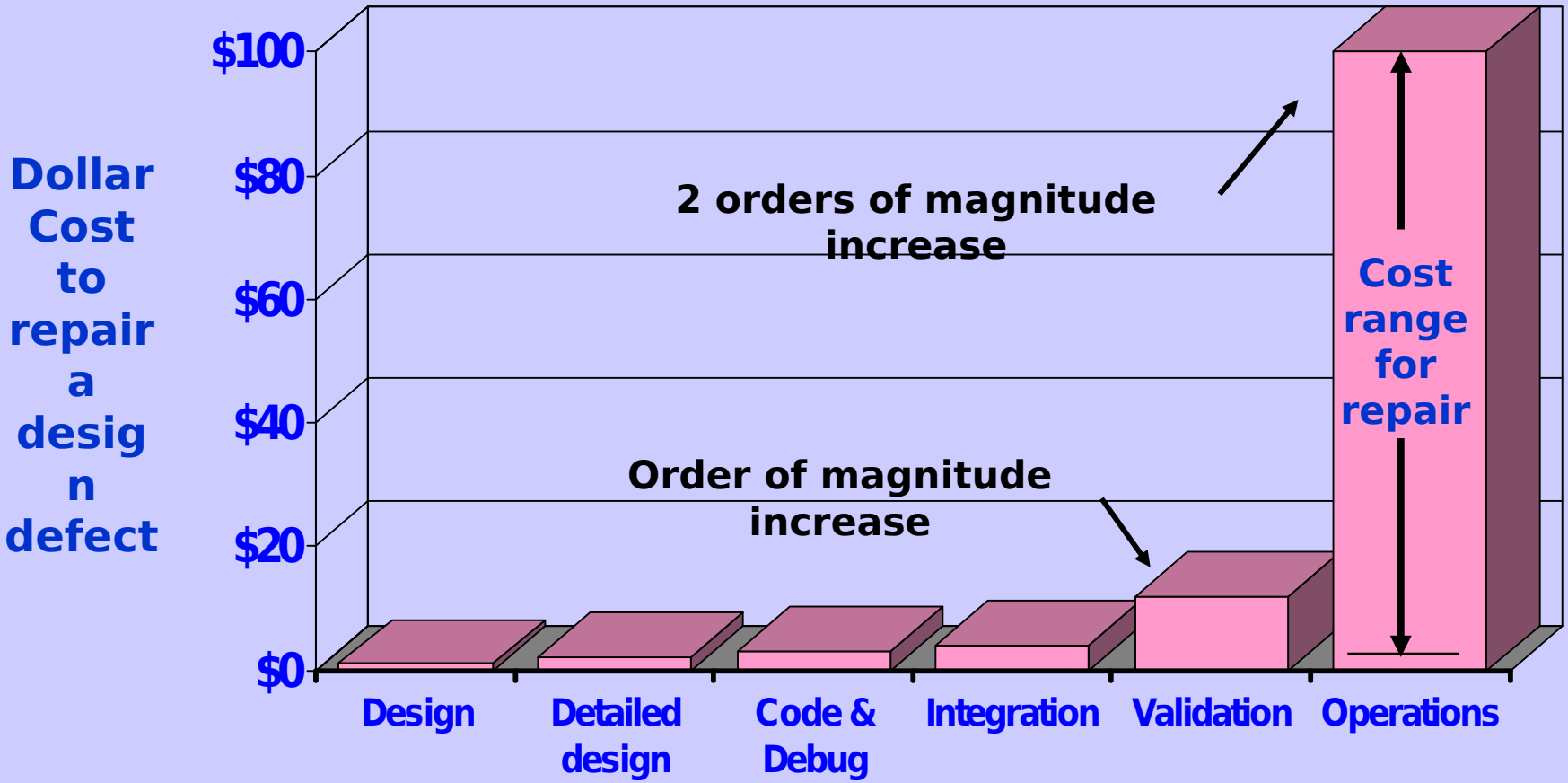
Best Practices Save Money:

Cost to Repair Design Defects



Phase when design defect was corrected *Source: SEPG Conference, 1999*

SEI found:
- **Rework is 40% - 50% of project costs**
- **High-maturity organizations can get rework to <10% of costs**

(Paulk, 1999)

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Benefits at SSC San Diego

Some testimonials from SW-CMM Level 3 Project Managers regarding results of PI:

- **We produced more complex builds in less time**
- **Implementing Peer Reviews and other process improvements significantly reduced the problems found and the testing efforts (e.g., reduced trouble reports by 71%, time to conduct tests by 33%, time to fix all trouble reports by 70%)**
- **Through process maturity we have observed increased productivity**
- **The project people have told me they would not work on another project without defined processes**
- **I travel a lot and having defined processes makes turnover completely seamless between me and my acting**
- **We are now consistently producing builds with zero defects**
- **We have better communication across the team, and people know what they are supposed to be doing**
- **I feel I am a much better project manager**
- **We have fewer surprises, last minute glitches, and fire drills**
- **We have fewer risks this year because we learned from our Risk Management Plan from last year**
- **We have been awarded new work based on our process improvement efforts**

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Benefits at SSC: the MATCALS project

- Life-Cycle Maintenance of 174K SLOC. Achieved ***CMM Level 2*** in January 1999; ***Level 3*** in October 2000
- Improvements and desk-top procedures were implemented in Design, Code, Unit Test, and Peer Reviews over 2.5 years for the Version M release. A comparison of results in the Unit Integration Testing of SCPs, SEPs, and Trouble Reports (TRs):

Measure	Ver. L	Ver. M	Change
a. SCPs and SEPs implemented	16	16	same
b. TRs written and fixed in testing	221	64	71% fewer
c. Total KSLOC modified	26	28	similar
d. Staff months to conduct tests	12	8	33% fewer
e. Staff months to fix all TRs	57.8	17.3	70% fewer
d+e Staff months for unit integration tests	69.8	25.3	64% fewer
e/b Staff months to fix each TR	0.26	0.27	similar
b/d TRs written per staff month testing	18.1	8.0	56% fewer
b/c TRs written per KSLOC modified	8.5	2.3	73% fewer
(d+e)/c Staff months per KSLOC modified	2.7	0.9	67% fewer

- ***Conclusion:*** Implementing Peer Reviews and other process improvements significantly reduced the problems found and the efforts expended in testing

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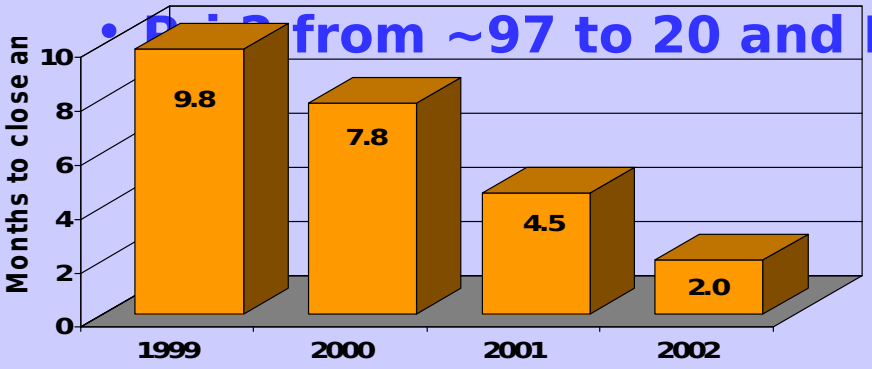
Benefits at SSC: Notable CMMI Data
Tactical Communication Solutions (SSC Code 24524)

- Center based product development organization relying on sales (no sponsor) of Data Link Gateway, TADIL J Host Simulator, etc.
- Valuable TCS measurements show improvements (since CMMI in 2000) have resulted in:
  - Avg STR closure time decreased by 80%
  - Average yearly business income increases of 22.3%
  - Significantly low or decreases in number and severity of STRs:
    - Pri 1 consistently under ~5
    - Pri 2 from ~97 to 20 and Pri 3 from 140 to ~20



Tactical Communications Solution (TCS) CMMI... presentation, dated October 2003

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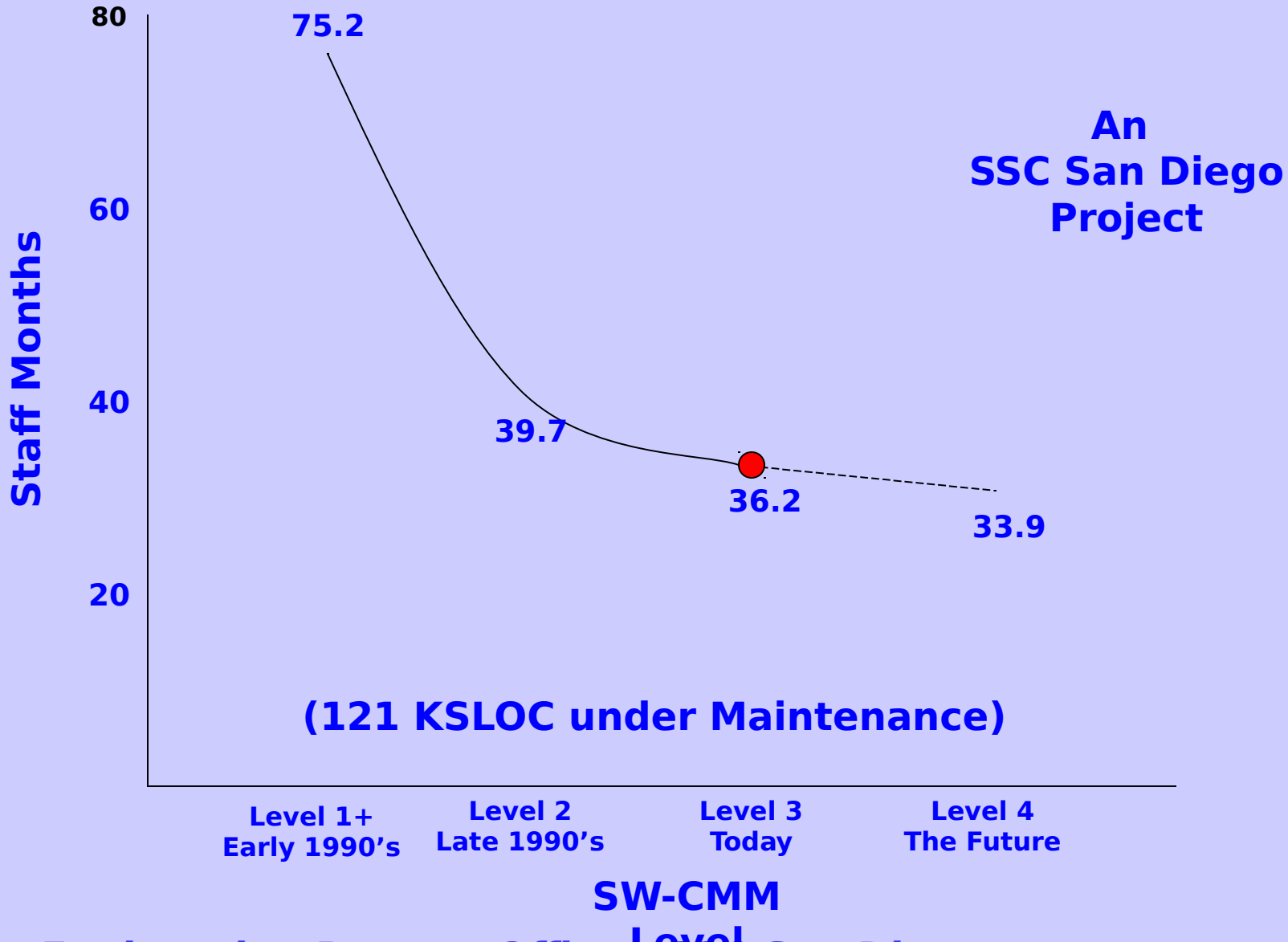
Joint Interagency Task Force Project

Process/Technology Improvements - Productivity



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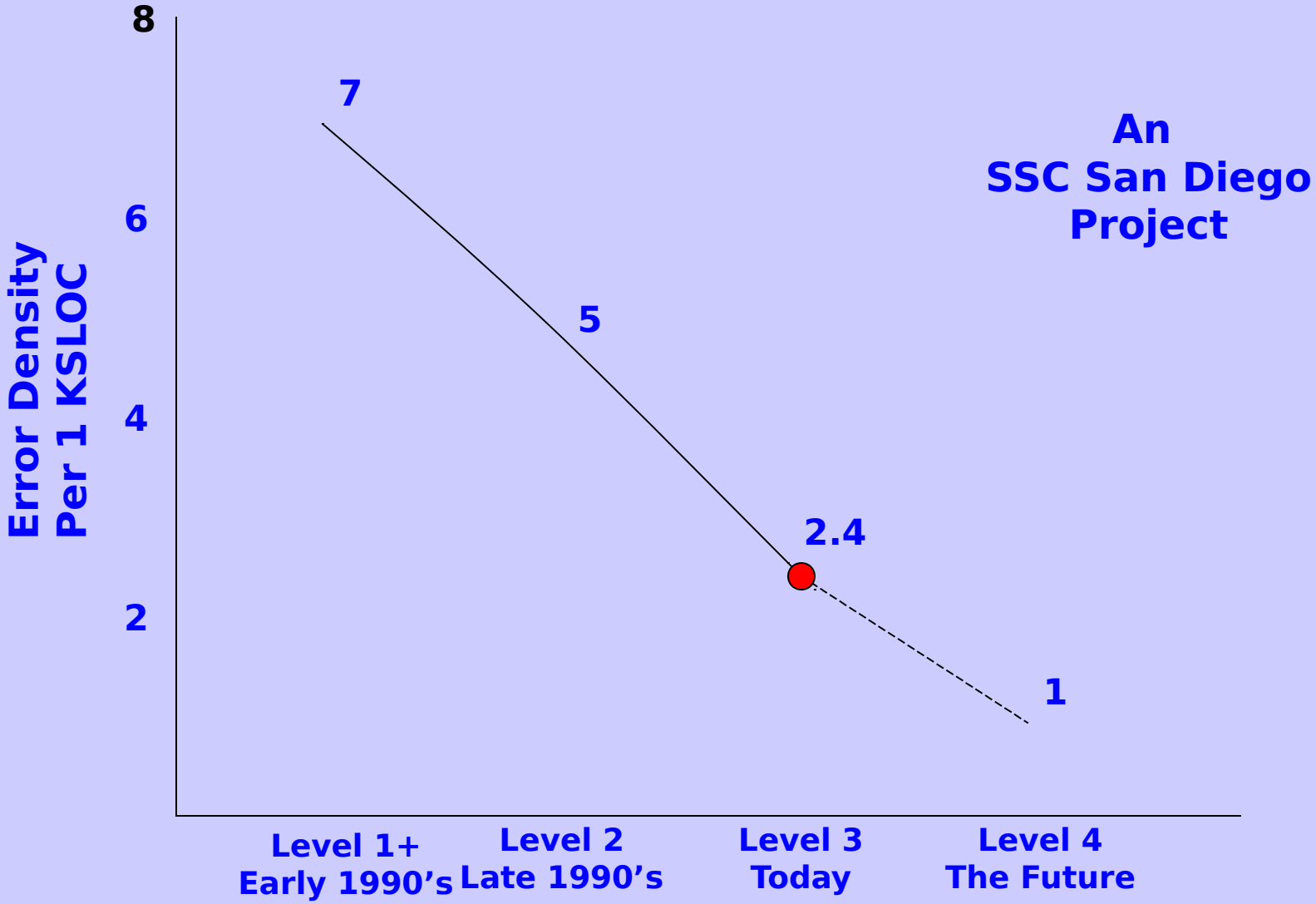
Joint Interagency Task Force Project

Process/Technology Improvements - Quality



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Quotes from SSC San Diego Projects

- Timely deliveries to Fleet
- Developers now understand the requirements
- Realistic schedules, understanding of requirements
- Increased sponsor confidence, improved coordination
- Morale of team improved
- Peer Review caught product defects before release
- We delivered on-time and within budget
- Team members now understand how their roles interact
- Less crisis management
- Reduced risk in the product release cycle
- Significant reduction of defects in testing
- We are SO much more organized than we used to be!

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More Benefits from SSC San Diego Projects

- Timely deliveries to Fleet — CDLMS
- Developers now understand the requirements — DCT
- Realistic schedules, understanding of requirements — ATDS
- Increased sponsor confidence, improved coordination — KSA
- Morale of team improved — TBMCS
- Peer Review caught code defects before release — SWaT
- We delivered on-time and within budget — WebSKED
- Team members now understand how their roles interact — CoRE
- Less crisis management — GCCS-M
- Reduced risk in the product release cycle — Tact. Comm. Sol.
- Significant reduction of defects in testing — Time Crit. Strike
- We are SO much more organized than we used to be! — JSIMS-M

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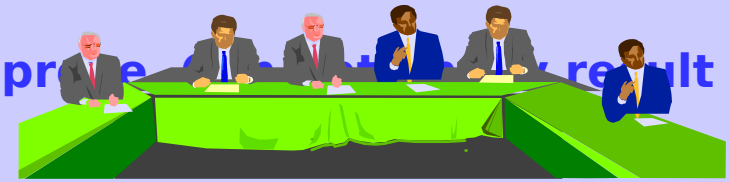
How is a Capability or Maturity Level Determined?

Standard CMMI Appraisal Method for Process Improvement (SCAMPI)

- **Description:** A structured appraisal in which a trained team examines an organization's current practices. It consists of interviews, questionnaires, and analysis designed to identify the current process capability.
- **Evaluators:** A team of 4-6 SCAMPI-trained people, external or internal to the organization
- **Process:** Typically one week of preparation off-site, then one week of
on-site interviews and analysis
- **Results:** Comprehensive verbal and written findings of strengths,
weaknesses, and areas to improve that may result in a validated maturity level.



CMMI

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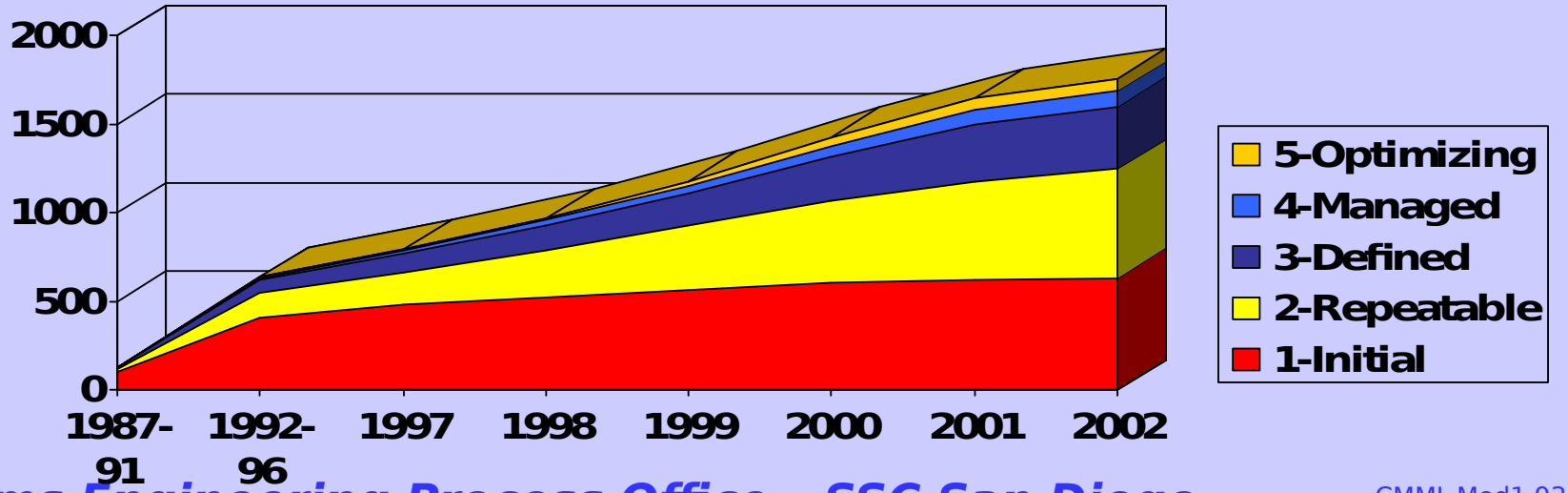
CMM Process Maturity Profile of Software Community

Maturity Level	1987-91	1997	1999	2001	December 2002
1- Initial	80%	61%	48%	38%	32%
2- Repeatable	12%	23%	30%	34%	37%
3- Defined	7%	14%	16%	20%	21%
4- Managed	0%	2%	4%	5%	5%
5- Optimizing	1%	1%	2%	4%	5%
Organizations reporting to SEI	130	795	1179	1641	1998



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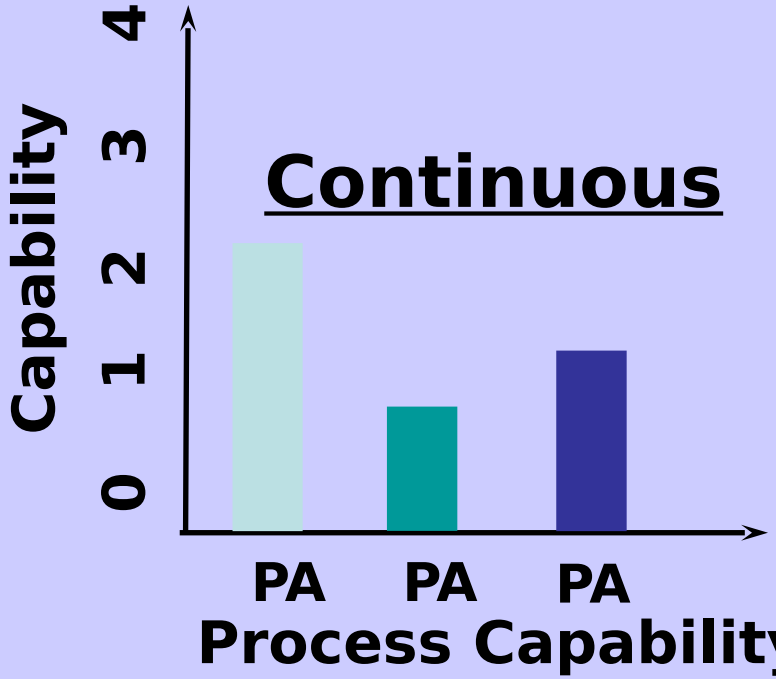
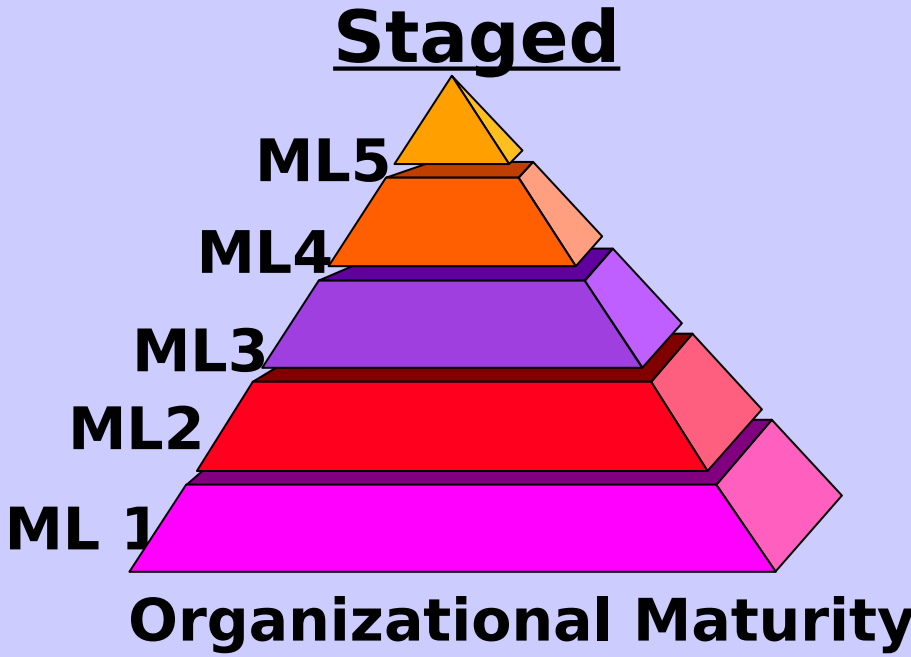
Comparing the Representations

- Both representations provide ways of implementing process improvement to achieve business goals





- Both representations provide the same essential content, but are organized in different ways

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Continuous Representation Overview

- The Continuous representation allows an organization to:
  - Select the order of improvement that best meets the organization's business objectives
  - Mitigates the organization's areas of risk
    - An organization can select appropriate processes for improvement
    - Appraisal output is a spectrum of "capability levels" (from 0 through 5) for each of the process areas appraised
    - Comparison among organizations on a process area by process area basis is facilitated

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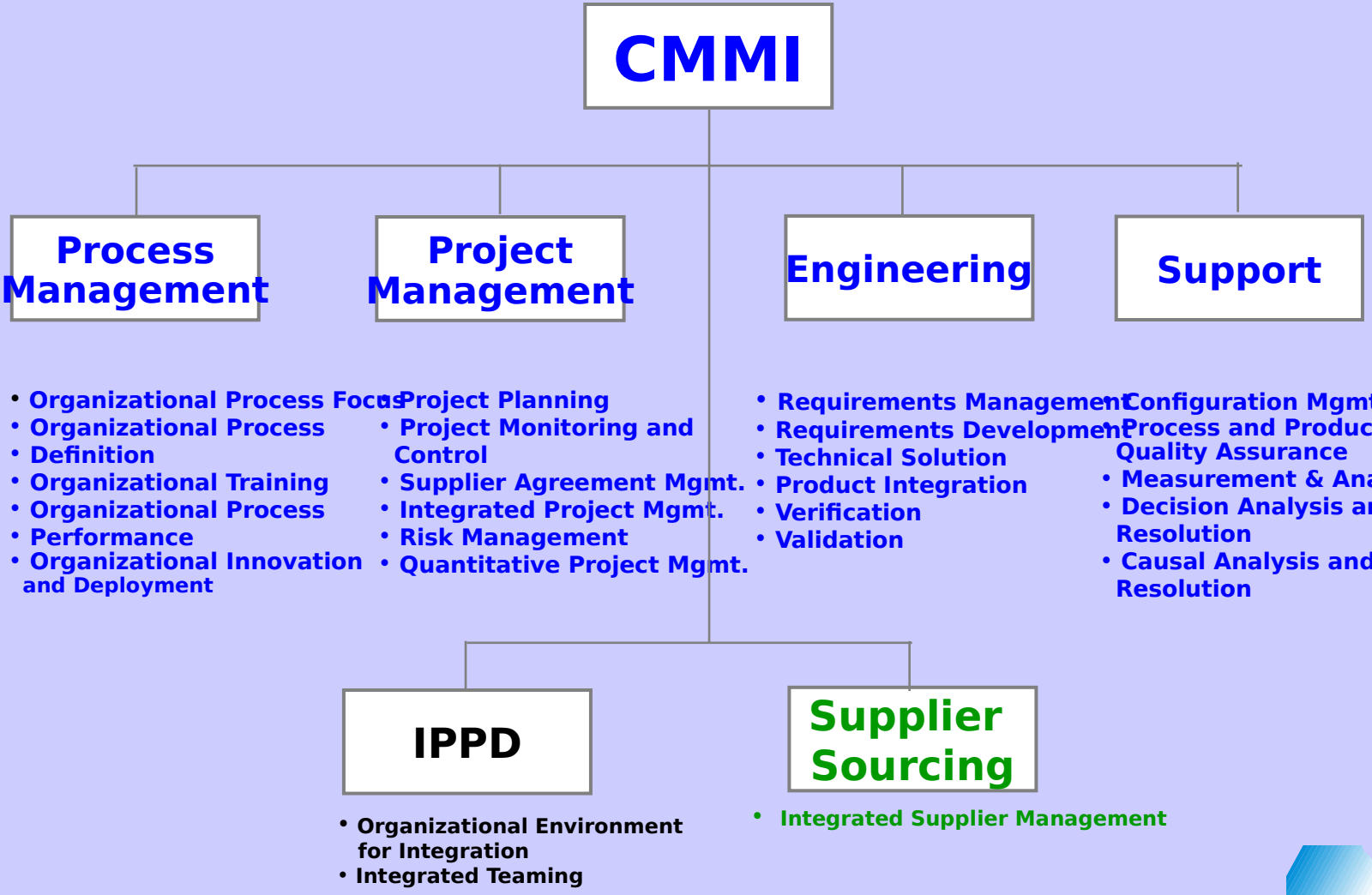
CMMI-SE/SW/IPPD/SS-Continuous



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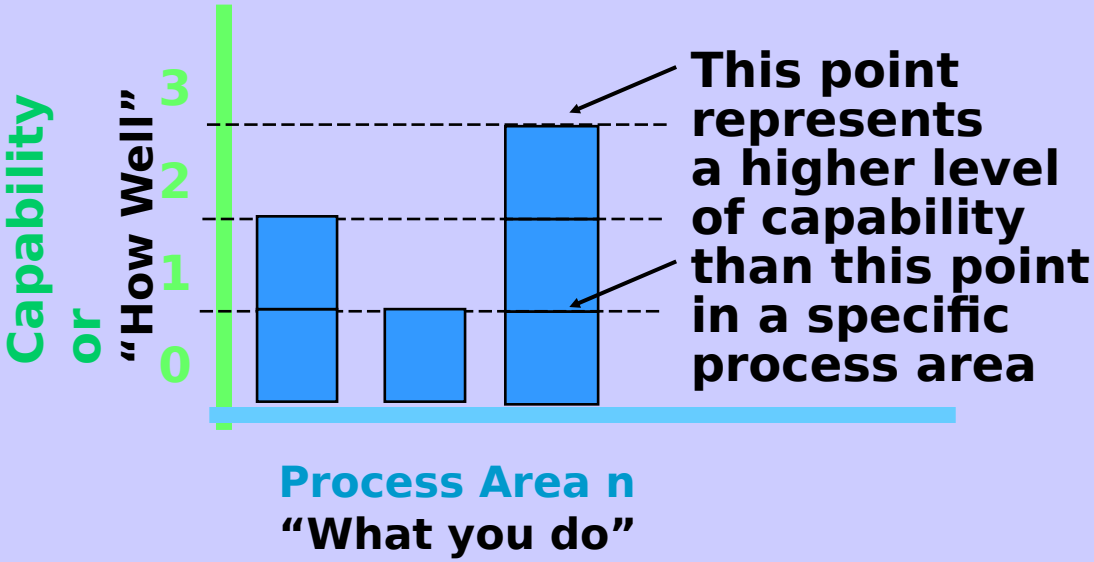
Representing Process Capability

Process Capability is defined as the range of results expected from following a system or software process

- **The capability of an implemented process can be represented by a bar**
- **Provides maximum flexibility for organizations to choose which processes to emphasize for improvement**



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How do I build the infrastructure ?

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A Level 2 Project

Project Managemen

A Project

Level 2 Processes

REQM
PP
PMC
SAM
MA
PPQA
CM

A Level 3 Organization

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SEPG

CCB

Level 3 Processes
OPF OPD OT
REQD TS PI
VER VAL DAR
IPM RSKM

Improved Processes

PAL / OMR

Projects tailor processes
Use historical data for estimates

Projects contribute to historical database (PDR

Process DCRs

Multiple Projects

Level 2 Processes
REQM
PP
PMC
SAM
MA
PPQA
CM

A Level 4/5 Organization

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SEPO

CCB

Process DCRs

Level 3 Processes
OPF OPD OT
REQD TS PI
VER VAL DAR
IPM RSKM

Engineering Process Analysis Group

Improved Processes

PAL/OMR

Quantitative Data Analysis

Level 4/5 Processes
OPP QPM
OID CAR

Projects tailor processes
Use historical data for estimates

Projects contribute to historical database (PDR

Process DCRs

Statistical Process Control

Multiple Projects

Level 2 Processes
REQM
PP
PMC
SAM
MA
PPQA
CM